UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT ON THE AGRICULTURAL AND ECONOMIC PHASES

OF THE

BAKER PROJECT [Oregon]

OF THE

BUREAU OF RECLAMATION

DEPARTMENT OF THE INTERIOR

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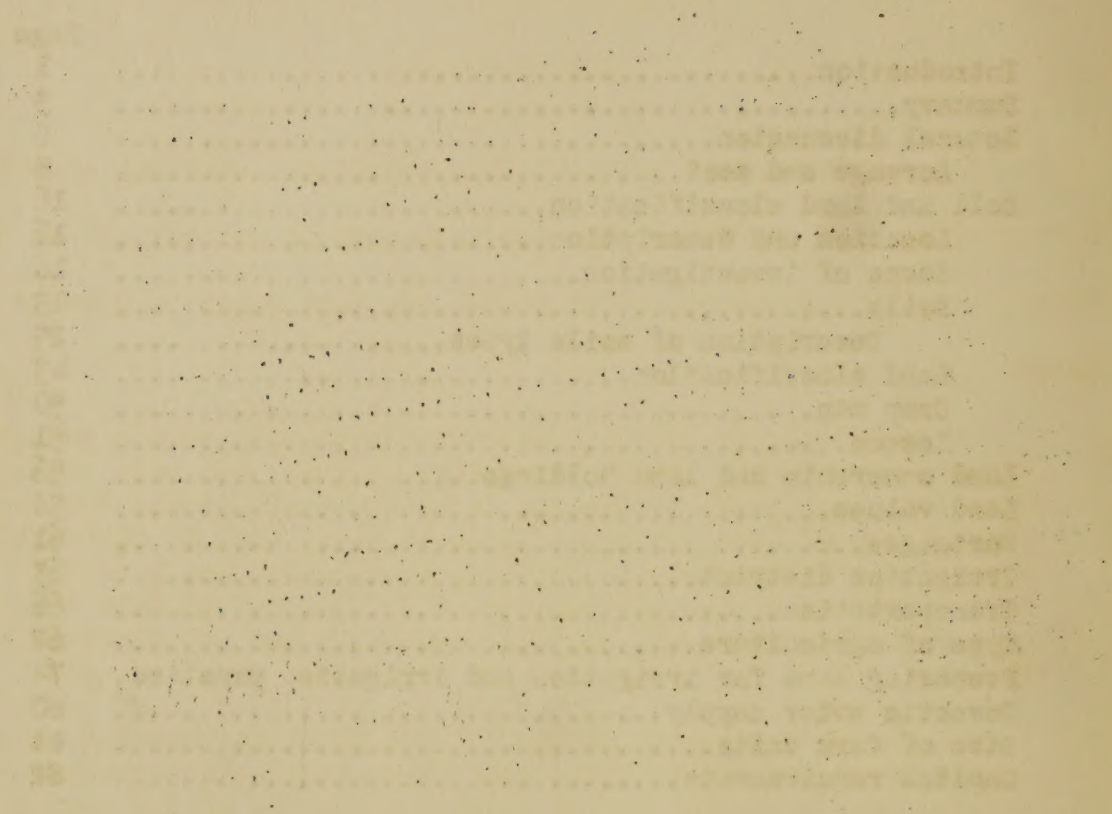

REPORT ON THE AGRICULTURAL AND ECONOMIC PHASES OF THE BAKER PROJECT OF THE BUREAU OF RECLAMATION, DEPARTMENT OF THE INTERIOR.

Introduction.

The investigation on which this report is based was undertaken in accordance with a letter from the Secretary of Agriculture to the Secretary of the Interior, dated August 29, that reads in part as follows:

> Referring to previous correspondence with Acting Secretary Finney regarding the Baker Irrigation Project, and your request that this Department advise you as to the agricultural and economic feasibility of this project, I wish to state that as arranged between Judge Finney and Mr. Pugsley, this matter has been referred to a committee of representatives of the bureaus of this Department that might be interested and this committee has now recommended as follows:
>
> 1. That a representative of the rural engineering branch of the Bureau of Public Roads make an agricultural engineering survey, as a basis for making careful estimates of the cost of clearing, leveling, and otherwise putting the land in condition for irrigation, and of the cost of providing the equipment necessary to operate a farm.
>
> 2. That a representative of the Bureau of Soils make a soil survey to determine the character and depth of the soil, the extent of the present and probable future danger from alkali in the soil or in the water, and the crop producing possibilities of the project. In the last connection this representative of the Bureau of Soils will of course consult the experts of the Bureau of Plant Industry and persons engaged in agriculture in the vicinity.
>
> 3. That a representative of the Bureau of Agricultural Economics make an economic survey for the purpose of assembling the economic data needed for intelligent judgment as to the possibility and probability of producing net returns sufficient to justify the capital investment needed, and the probability that the land will be put to a use that will produce such a return within a reasonable time.

* * *

> The committee is of the opinion that the work can and should be completed within a period of three months. It is understood, of course, that the representatives of this Department will make use of whatever data, along the lines indicated, your Department may have, and that they will collect only such additional data as they may consider necessary for a comprehensive report on the agricultural and economic aspects of the project.

W. W. McLaughlin of the Division of Agricultural Engineering of the Bureau of Public Roads, M. H. Lapham, of the Bureau of Soils, and R. P. Teele, of the Division of Land Economics of the Bureau of Agricultural Economics were designated to make the investigation. Mr. Teele was designated to act as general representative of this Department to make detailed arrangements for the work and compile the report.

A report on the Baker project, entitled "Revision of Plans and Estimates of Baker Project, Oregon, by Board of Engineers, James Munn, J. L. Savage, C. C. Fisher, January, 1923", supplied by the Department of the Interior, was taken as the basis for the investigation. Throughout this report, the report of the Board of engineers is referred to as the Reclamation report.

Field work was begun early in October and completed by the middle of November, 1923.

Some difficulty was experienced in getting satisfactory maps to serve as a basis for field surveys, as those prepared by the engineers of the Bureau of Reclamation could not be located until about the time the field work was completed. Mr. W. G. Steward, the

local representative of the parties who had originally promoted the Baker Project as a Carey Act enterprise supplied copies of large-scale topographic maps prepared in connection with that enterprise, and maps prepared from these were used in the field work. It was found that the canal lines on these maps do not correspond exactly with those on the maps obtained later from the Chief Engineer of the Bureau of Reclamation, and consequently the total areas shown in this report will not check exactly with those given in the reclamation reports. However, the differences are so small as to have no appreciable effect on the general result of the investigation.

Mr. Steward allowed the use of his office and drafting equipment and supplied maps free of charge, and aided in every way possible in the carrying out of the work.

The maps in this report are pantagraph reductions of tracings made from the topographic maps referred to.

SUMMARY.

The soils of the Baker Project occur predominantly on up-land terraces and slopes with minor areas occupying stream bottoms, low terraces and local flats or basins.

The surface soils of the upland terraces are of favorable texture, free from alkali salts, and well drained. They are capable of producing alfalfa and other crops under irrigation, where topographic conditions are favorable. The smoother areas, however, are underlain by heavy impervious subsoils or by cemented hardpan horizons which tend to restrict

percolation and subdrainage and to limit normal development of deeply rooted crops. In the areas of rougher or eroded topography occurrence of hardpan substrata is less consistent or is entirely wanting but much of these areas are too steep to be economically irrigated.

The soils of the lower lying terraces and stream bottoms are deep, friable, fertile, and easily irrigated, but drainage is less completely developed and accumulations of seepage waters and alkali salts occur. Further extension of the affected areas is to be anticipated where adjacent to extensively irrigated upland areas.

A classification of the land indicates that of the area surveyed including all the lands lying between the North and South Side main canals, as indicated on the accompanying maps, but excluding 1148 acres of high areas lying above reach of gravity water, 6708 acres or 16.5 per cent of the total area mapped consists of first class irrigable land of smooth surface, gentle slope and easily irrigated; 5983 acres or 14.8 per cent consists of second class land, less easily irrigated; and 9686 acres or 23.9 per cent consists of third class land occupying steep slopes, subject to erosion, and demanding experience and skill in the handling of water.

Of the remainder, 4340 acres or 10.7 per cent of the total area surveyed occupies the river bottoms of poorly developed drainage and mainly excluded from the Project; 2583 acres or 6.4 per cent occupies low valley terraces, local basins, and minor stream valleys well adapted to irrigation at present, but in which drainage will become impaired under extensive irrigation of the adjacent uplands; and 10095 acres or 24.9 per cent consists of areas too steep, stony, or irregular and rough

to justify expense and difficulty which would be involved in irrigation.

The irrigable area as determined by the soil and land classification surveys, reduced by 6 per cent for rights of way, is about 21,000 acres, or 8,000 acres less than that reported by the Reclamation board of engineers.

The reduction in acreage will make possible some reduction in cost of construction, but the average construction cost per acre will be considerably greater than that reported by the board of engineers. As the determination of the extent of the possible reduction in cost is not within the province of this investigation, no attempt has been made to determine exactly the probable average cost per acre.

The greater part of the cost is apportioned to land not now in cultivation, that will have to be disposed of to settlers. A large part of this area is public land, that would be opened to homestead entry. The present valuations of unimproved private land are low and if selling prices conform to these valuations there will be little choice between homesteading and purchasing unimproved land.

At present there is little demand for agricultural land, and improved farms in many established communities can be purchased for less than the water charges on this project. It seems probable, therefore, that there would be difficulty and delay in obtaining settlers.

Stock raising is the prevailing type of agriculture in the valley. The character of the land to be irrigated, the exhaustion of the free range, the limited grazing capacity of nearby National forests, and the high cost of water preclude the extension of this type of agriculture to the new lands.

Under the prevailing climatic and marketing conditions, the most promising type of agriculture is dairying and the incidental raising of cattle, hogs, and poultry, with small areas devoted to clover and alfalfa seed and other specialties.

The very high cost of water makes it imperative that settlers bring their whole irrigable area into production quickly. A settler should have sufficient capital to bring his farm into full productivity before the regular payments on the construction charge begin. This requires that a settler have a capital of about $7000 for cash payments, improvements and equipment and expenses until the farm is in full production.

Under present conditions the returns from this type of agriculture are not sufficient to pay expenses and meet payments for water as they fall due, and leave any appreciable labor income other than living expenses or pay any interest on investment.

Oregon is now producing more dairy products than are consumed in the state; and the Pacific States, as a group, are self sustaining. The Nation-wide tendency to look to dairying as a cure for adverse agricultural conditions makes it appear that returns from dairying will in the future be smaller rather than larger than at present. In any event, with the State producing a surplus of dairy products, this section will have the handicap of heavy freight charges to any outside market to which it may ship.

On account of the rough topography, the land of this project should be subdivided on topographic lines, rather than by Government subdivisions.

On account of the extremely varigated character of the land, both as to soil and topography, it will not be feasible to fix the farm unit on an acreage basis. The producing capacity of the land should be made the basis of subdivision, and the whole area should be subdivided into feasible farm units containing both irrigable and non-irrigable land on the basis of careful surveys. There should be provision for apportionment of cost on the basis of the farm units thus created rather than on an acreage basis. If the project is to be built, there should be very careful study of an equitable apportionment of cost.

The irrigation district organization is not adapted to a project containing so large a proportion of public land as does this project, because public land until entered does not contribute to meeting the cost of either construction, or operation and maintenance. Nor is the district form of organization adapted to a project with a construction cost so high that the land owner can not carry an increase in the amount originally apportioned to his land, that may occur through the prorating of deficits due to delinquencies on other lands.

Since it is not probable that settlers with the amount of capital necessary for the development of this project can be obtained in any considerable number, and also since settlers on the public land will not have title to their land and consequently will have no security on which to obtain loans, some public provision for credit for obtaining improvements and equipment will be necessary if settlers are to be placed on the land.

The estimated average construction cost per acre for this project is from 50 to 100 per cent higher than that for the other Government reclamation projects, while the agricultural advantages are below those of some of the projects having much lower cost. The economic conditions on these other projects should be given careful consideration in deciding upon the feasibility of this project.

GENERAL DISCUSSION.

In the following paragraphs the general results of the investigation are given, based on the detailed reports on the several phases of the work, given later.

ACREAGE AND COST.

The irrigable acreages under the North and South Canals, as given in the reclamation report are presented in the following table:

Irrigable Area Given in Reclamation Report.

	North Canal Acres	South Canal Acres	Total Acres
Gross area under canals	17,984	16,370	34,354
Deductions:			
Over 20% slope	1,415	2,570	3,985
Too high	1,123	582	1,705
Rocky	457	197	654
With partial water supply	2,949	234	3,183
Right of way, 6% of irrigable area.	763	770	1,533
Total deductions	6,707	4,353	11,060
Net irrigable area	11,277	12,017	23,294*

*Note: - It is assumed that of the gross area, 3,183 acres, listed as having partial water supply, the equivalent of approximately 1,700 acres will require canal capacity and a full water right, making a total of 25,000 acres requiring a full right.

The estimated cost given in the Reclamation report is as follows:

Estimated Cost Given in Reclamation Report.

Grand total, estimated cost - - - - - - - - - - - - - $4,140,770.00

Average cost per acre:

New lands (25,000 acres)	157.84
Old lands (4,000 acres)	48.71

The classification of the land in the project made as a result of the soil survey is given in the following table:

Classification of Land in Baker Project on Basis of Soil Survey.

	North side	South side	Total
Gross area	19,347	21,198	40,545
Deductions:			
Right of way(1)	710	633	1,342
River bottoms, poorly drained	1,933	2,407	4,340
Local bottoms, impaired drainage	1,559	1,024	2,583
Steep, rocky, and high(2)	4,043	7,202	11,245
Total deductions	8,245	11,266	19,511
Irrigable land (3)			
First class	2,931	3,374	6,305
Second class	2,706	2,917	5,623
Third class	5,465	3,641	9,106
Total irrigable	11,102	9,932	21,034

(1) Taken at 6 per cent of irrigable area, as was done in Reclamation report.

(2) Areas above the canal grade are taken from Reclamation maps.

(3) All areas reported by soil survey as irrigable are reduced by 6 per cent for right of way.

There are certain apparent discrepancies between the two reports which are explained below.

The difference between the gross area under the canals given in the Reclamation report - 34,354 acres - and that reported by the soil survey - 40,544 acres - is accounted for by the fact that the former report does not include in the gross area lands in the river bottom that are excluded from the project because they are now too wet or too alkaline to benefit by the new construction, and other lands that are excluded because they have now a full water supply; while the latter report includes all land lying between the canal lines and the river.

The "net irrigable area" given in the Reclamation report refers to land requiring a full water supply from the proposed project. The area of land of this class used in the Reclamation report in computing average cost per acre was 25,000 acres. To this is added 4,000 acres requiring stored water. On the other hand, the irrigable area shown by the soil survey - 21,034 acres - includes all land that it is feasible to irrigate, in the opinion of the soil experts who made the survey, including the land now irrigated, less 6 per cent for rights of way. Taking the totals of all lands that are to receive water the present survey shows a reduction from 29,000 acres given in the Reclamation report to about 21,000 acres, or 8,000 acres. This 8,000 acres is distributed as shown in the following table:

Land Under Canals Classed as Non-irrigable.

Items	Reclamation report	Soil report	
		Acres	Increase over Reclamation
River bottoms, poorly drained	3,500	4,340	840
Local bottoms, impaired drainage	0	2,583	2,583
Steep, rocky, and high	6,344	11,245	4,901
Total	9,844	18,168	8,324

In the Reclamation report the area requiring stored water only is given as 4000 acres. Assuming that the irrigable area reported in the soil survey includes the same number of acres requiring stored water only, there are 17,000 acres requiring a full water supply, and 4,000 acres requiring stored water only. In apportioning cost between the two classes of land the board of engineers made the construction charge to the latter lands about 30 per cent of that to the lands requiring a full water supply. Using the gross construction cost given in the Reclamation report and apportioning this on the irrigable area shown by the soil survey on the same basis as was done before gives the following result.

Estimated Construction Cost per Acre.

Item	Reclamation report	Soil survey
Land requiring full water supply	$157.84	$227.46
Land requiring stored water only	48.71	68.24

The soil survey classes as non-irrigable 2,583 acres of "local bottoms, impaired drainage". This land lies in narrow strips in the bottoms of the valleys among the rolling hills that constitute the major portion of the lands not now irrigated. This land is excluded because of the belief that when the slopes above it are irrigated it will become too wet for cultivation and, lying as it does, in narrow strips, the cost of drainage will be greater than the value of the land. Such land will be susceptible of cultivation for a few years, and will have some value for pasture after it has become too wet for cultivation. Probably it should bear some of the construction cost, although it need not be considered in determining reservoir and canal capacity, because it will cease to need water before all the other land is using a full supply.

The exclusion of land because of steep slopes and rough and rocky surface is the largest factor in reducing the irrigable acreage. Much of the land excluded for these causes will have some value for pasturage, feed lots, etc., and will receive some indirect benefits from the irrigation of adjoining lands. Probably it, too, should bear a small part of the construction cost.

Reducing the area to be supplied with water will make possible some reduction in the construction cost, but the reduction in cost will not be as great proportionally as the reduction in the acreage to be served. It is not within the province of this investigation to estimate the possible reduction in construction cost, and, in view of the fact that this is indefinite, it does not seem advisable to make any definite suggestion as to the amount, if any, that should be apportioned to the lands classed as non-irrigable. Taking these things

into consideration, the average cost per acre on the irrigable land would still be higher than that given in the Reclamation report, but lower than that based on the existing estimate of cost and the irrigable area shown by the soil survey. With the understanding that it is not to be taken as anything more than an approximation, for the purpose of further discussion, the cost to land requiring a full water supply will be taken as $200 per acre and the cost of stored water only at $60 per acre.

The estimates of cost given in the Reclamation report include no charge for drainage. Most of the land in the river valley now needing drainage is excluded from the project, and need not be considered. The larger part of the land now producing good crops is comparatively level, and lies in the river valley between the wet bottom land and the base of the hills. When the higher land is irrigated much of the land now productive will need drainage. It is not possible to predict exactly what land will need drainage, when the necessity will develop, or how much drainage will cost. The land that will require drainage is principally that which requires stored water only, and owners of such land should look forward to being called on to pay for drainage at some future time. If the cost of drainage is spread over the whole district, it will, of course, raise the cost on all land.

As most of the land requiring a full water supply lies in the hills, no large part of it will require drainage.

Irrigation Practice.

While the lands of the project are quite rolling and cut up by draws, and large areas have been eliminated as high, rocky, or steep, the surfaces of the lands classed as irrigable are fairly smooth, and the vegetation covering these lands is, in most places, not heavy. As a consequence, clearing and leveling will not be difficult or expensive.

The soils, generally, are not deep, giving them a rather limited water-holding capacity and making frequent irrigation necessary. The depth of soils varies greatly within limited areas, making it very difficult to maintain the proper amount of soil moisture throughout a field, as the more shallow portions will dry out while the deeper portions still have sufficient water. This will tend to decrease yields, as crops will be spotted.

Most of the irrigable land has rather steep slopes. This limits greatly the range in methods that may be used safely in applying water, and limits the size of streams that may be used, thus increasing the time required for watering fields. With cultivated crops it will be necessary to use very small streams and give them constant attention.

The steep slopes also will make all farming operations more difficult and time consuming than on more nearly level ground.

Type of Agriculture.

The prevailing type of agriculture in the Lower Powder Valley is the growing of hay and grain, the raising of cattle and sheep that are run on the vacant public lands and on the nearby National Forests, with some dairying on many of the farms.

Climatic and marketing conditions do not permit of great variation from the present cropping system; and the small land holdings required by

the Reclamation Act and, particularly, the high cost of water, preclude the extension of the existing type of agriculture to the new lands. Future development must be based largely on the continuance of the present cropping system, with the substitution of dairying for the growing of range stock.

Capital Requirements

Estimates of capital requirements are based on farm units of 80 acres of first class irrigated land, or its equivalent, farm enterprises based on dairying, and the bringing of such a farm to full production before regular payments on construction cost begin. It is estimated that the establishment of such a farm and its operation to a point where annual receipts will exceed cash outlay will require a capital of $7,087. It is estimated that a settler with that amount of capital, either in cash or necessary equipment, can acquire such a farm, maintain himself and meet his payments, but without labor income other than an allowance of $600 per year for living expenses, without interest on his investment, and with almost no margin for contingencies. One who has to borrow any considerable portion of the required capital and pay interest on it will not be able to meet the payments on construction charges as they become due.

The above estimates relate to first class land and experienced dairymen and allow for no misfortune of any character. Only about 30 per cent of the irrigated land is rated as first class; while about 43 per cent is rated as third class, indicating greater costs or decreased returns, or both. It appears, therefore, that it is probable that only a few farmers can be expected to be able to meet the payments for water as they fall due. Under the district organization delinquencies on any part of the land must be met by the other land, and this would tend to break those who might succeed otherwise.

If a farmer can maintain himself and meet his payments, the value of his farm at the end of the 20-year period of repayment will, in some measure, make up for the lack of labor income and interest on his investment.

SOIL AND LAND CLASSIFICATION.

Location and Description.

The Baker Project covers the greater part of the Lower Powder River Valley in northern central Baker County, Oregon. The City of Baker on the Portland-Granger line of the Union Pacific Railway, and lying some 18 or 20 miles west of the center of the project, is the principal railway and shipping point. The project includes two units lying on either side of and about equally divided by the Powder River, which drains in a southeasterly direction to the Snake River. The area including the intervening valley lands has a maximum width of about 7 miles and extends through a distance of about 16 miles. From the project as proposed however, have been excluded by the Bureau of Reclamation certain areas of lands having present water-rights or of unfavorable drainage, soil or topography.

The greater part of the lands included within the project occupies upland terraces and benches having a maximum elevation of about 3,000 feet and sloping on either side of the valley toward the river. Their lower margins usually terminate in steep escarpments which border the lower lying lands of the river valley at an elevation of about 2,700 to 2,800 feet.

The degree of slope is in all cases sufficient to furnish good surface drainage and in most cases such that precautions and skill will be necessary in the distribution and handling of irrigation water. Drainage of these upland terraces is further favored by the fact that they are dissected by creeks, and by deep, narrow, steep-sided coulees or drainage courses usually

having flat bottoms traversed by minor intermittent stream channels which carry water only at infrequent intervals. The last mentioned are most frequent upon the South Side Unit of the project which has no perennial streams tributary to the Powder River. The North Side Unit however, is traversed by a number of minor streams of variable but more regular flow. The more important of these, enumerating from west to east, include Houghton, Tucker, Clover, Balm and Goose Creeks which traverse areas of well defined alluvial bottoms separated from the upland terraces by steep slopes. Erosion by headwaters of the coulees or minor drainage courses has in many instances encroached upon the area of the higher upland terraces giving rise to local basin-like depressions of smooth to irregular surface. In the vicinity of the river bottoms, the Project includes considerable areas of lower-lying benches or terraces of smooth surface, less pronounced slope and less dissected topography. The general topography of the project may be characterised as rather strongly sloping or rolling to steep and dissected. While this condition is such as to favor drainage of the upland terraces, the adjacent coulee and other stream bottoms are less favorably situated.

The lands included within the project are mainly unoccupied and covered with sage brush vegetation. Greasewood appears only in a few localities of impaired drainage. Present settlement is practically confined to the lands of the river bottoms and adjacent low terraces extending throughout the main valley, and to creek bottoms and adjacent areas of uplands in the eastern part of the project in which water for irrigation is obtained from Goose Creek, Balm Creek, and other north side streams.

The poorly drained lands of the river bottoms in which accumulations of alkali salts more or less regularly occur are utilized mainly for pasture

in connection with dairying and stock raising. The lands at present irrigated are utilized mainly for alfalfa and dairying.

Scope of Investigation.

The work of the Bureau of Soils in this investigation involves a study of the soils with regard to their adaptability to agriculture under irrigation, and the construction of maps having a three fold purpose, as follows:

1. A soil map showing extent and distribution of the various types of soils classified on the basis of their salient physical characteristics. (Map No. 1)

2. A land classification map based upon prevailing conditions of topography as related to irrigation problems in the distribution and handling of water. (Map No.2)

3. A crop map indicating present utilization of the lands of the valley. (Map No. 3)

Owing to want of definite information during progress of the field work as to exact areas within the outlines of the project which had been excluded by the Reclamation Service from consideration, no attempt was made to segregate these and the entire area lying between the preliminary location of the North and South Side Main canals as indicated upon maps at hand was included in the survey.

The base maps used in platting the soil and land classification maps in the field consisted of prints made from maps of the North and South Side Units secured through the kindness of Mr. W. G. Steward of Baker. These maps were drawn on a scale of 1 inch to 1000 feet, showing contours at intervals of 5 feet and had been made by pantagraph reduction of large scale sheets of a previous survey antedating the proposed project. Location of main canals determining the boundaries of the Project were of preliminary character and some errors were probably introduced by pantagraph reduction,

since instances were encountered in which location of topographic features failed to check closely with established corners or land lines. Furthermore, maps furnished by the Bureau of Reclamation subsequent to completion of the field work, indicated some later changes made in location of the main canal lines and in areas of lands excluded from the project. The maps presented with this report do not therefore everywhere agree with the latest indicated canal locations and boundaries of the proposed project, and data given from results of planimeter measurements are approximate and not necessarily strictly comparable. Since however, this survey includes all the lands lying between the main canal locations as indicated upon the maps then at hand, results presented should be representative; and it is believed that deductions and adjustments necessary to bring the area included in this survey into conformity with the final outlines and inclusions of the project, can be made later.

Data represented on the crop map were sketched in the field on township plat blanks on the standard one inch scale.

The soil and land classification maps have been platted further on pantagraph reduction in scale forming base map accompanying this report.

The crop map has been enlarged to the same base with consequent magnification of errors but is believed to be substantially correct.

Soils.

The soils of the project are derived from a variety of materials which have been modified to a variable extent through the agencies of weathering, drainage and erosion. They are in consequence represented by

a number of more or less distinct soil types which frequently occur in small and intimately associated areas.

The most extensive and important soil forming materials consist of a series of old unconsolidated sedimentary beds forming the upland terraces. These are represented by strata of fine sands, fine sandy loam and of silt and clay in which the materials of medium to the finer grades of texture predominate. They are predominantly of light color and in places the beds appear to have been disturbed with more or less faulting, fracturing and upturning or tilting. The materials include in some localities beds of stratified volcanic ash and tuffs, and extensive areas of light gray to white chalk-like deposits frequently many feet in depth, are exposed in the eroded hill slopes in various parts of the area surveyed. These are of fine texture and rather massive structure, and miscropic examination indicates the material to include a large amount of sharply angular to needle-like crystals and fragments of quarts with some evidence of diatomaceous remains. It is probable that much of these materials was deposited in lake waters which appear to have at one time occupied portions if not most of the valley, into which were carried by winds and waters quantities of finely abraded volcanic ash with the products of weathering and erosion of the adjacent rocks and soils. These deposits extend to undetermined depth and appear to be mainly of siliceous character, though lime cemented nodules, seams, and encrustations commonly occur in their upper part. They are of most typical and extensive occurrence on the South Side Unit but are also prominent in exposures on the west side of Goose Creek and in other localities on the north side of the River. The surfaces of the upland terraces, however, where not removed by subsequent erosion, are usually capped by deposits of water-worn gravels or

of soil materials in which rounded gravels are more or less conspicuous. It would appear that the surface of the former lake sediments has been veneered with old stream deposits and that the surface soils of the upland terraces where undisturbed, consist mainly of old alluvial deposits having an admixture of a variable amount of wind-borne materials.

These deposits of mixed lake-laid, stream-laid, and wind laid materials rest upon the rocks of the region at variable depth. In the central part of the South Side Unit these are deeply buried and have no influence upon surface soils. In the eastern and western portions of the project, however, basaltic rock and associated volcanic tuffs including beds of ash and pumice, closely approach the surface and frequently outcrop. Associated green stones also occur about the margins of the area surveyed. In the central part of the North Side Unit, mainly between Tucker and Clover Creeks, areas of quartz bearing crystalline rocks of granatoid texture also prominently occur. These areas of shallow bedrock have had an important effect upon the soils and areas of residual soils derived from the underlying consolidated rocks occur in these localities.

The lower benches and bottoms of the river and minor stream valleys are occupied by flat to gently sloping areas of alluvial soils derived from a mixture of rocks and other materials.

The arable soils of the area surveyed have therefore been classified under three main groups of soils, each of which is represented by two or more soil types.

These three main groups of soils are designated as (1) Residual soils (2) Old valley filling soils, and (3) Recent alluvial soils.

The residual soils are derived from weathering in place of the underlying rocks, and have been but slightly modified by admixture of water-laid or wind-laid materials. They are predominately of rolling to hilly or steep

topography, shallow depth, and moderately low to low content of organic matter. They are frequently stony, but where sufficiently free from boulders and stone fragments and not too shallow are capable of irrigation and well drained, but are of minor extent and importance.

The old valley-filling soils are derived by weathering in place of the old unconsolidated deposits of the benches and terraces. They are most extensively and typically developed on the higher upland terraces but occupy the entire series of benches from the highest to those having an elevation of but a few feet above present alluvial flood plain of the streams. Into these soils has entered an admixture of mineral materials representing a variety of rocks.

The soils of these higher terraces are predominantly of light color, low organic matter content and usually contain small to abundant amounts of water-worn gravels. The gravels are frequently accumulated upon the surface and in some localities of small extent form conspicuous gravel pavement. The subsoils are characterized by occurrence of cemented hardpan layers of both calcareous and noncalcareous character, or by soft, lime-cemented nodules and seams; or mechanically-compacted horizons.

The soils of this group vary in topography from smooth and gently sloping to eroded and rough according to degree of erosion. Surface drainage except in case of a few of the lower-lying and flatter areas, is usually favorable but subdrainage is frequently restricted. In some of the types these conditions are pronounced, especially in the eastern part of the project, and will effectually limit penetration of irrigation waters and normal development of plant roots. Much of the hardpan, where of calcareous formation which predominates throughout the middle parts of the project, is, however, relatively soft and fragmental and appears to be penetrated at least

partially by roots. It is probable that this will not completely arrest percolation and it might become softened under continued irrigation, and areas of like character are being successfully utilized for growing alfalfa under irrigation at the present time, though spots in which the cemented layers occur at shallow depth become conspicuous under conditions of limited water supply. Problems of sub-drainage due to compacted or cemented soil horizons are, owing to pronounced slope and frequency of dissecting coulees, likely to be more critically reflected in accumulation of seepage waters and alkali salts in the adjacent soils of the lower benches and alluvial bottoms.

The old valley-filling soils of this survey are represented by five types of soil differing in origin, subsoil characteristics, topography, and agricultural possibilities. All of these are capable of utilization where topographic conditions will permit, but a considerable proportion of these soils is of steep and unfavorable topography or irrigable with difficulty, and areas of the rougher topography should be eliminated.

The recent alluvial soils consist of recent stream-laid deposits which have not been materially modified through the agencies of weathering, leaching, or development of hardpan layers since deposition. They are confined to the bottoms of the river valley and of the tributary streams and coulees and occupy areas of flat or smooth surface. They are characterized by friable and permeable subsoils, are usually of high moisture-holding capacity, and are easily cultivated and productive where not unfavorably affected by accumulation of seepage or drainage waters and alkali salts. Drainage conditions are, however, imperfectly developed and a large proportion of the soils of the river bottoms are already waterlogged or poorly drained, and extensive areas of alkali accumulation occur. The most of the areas in which such conditions are pronounced have already been excluded from the project. It is to be anticipated that with extensive irrigation of the higher lying lands, this

condition would become further aggravated, and that in the absence of an extensive system of drainage coordinating with the irrigation system, a large proportion of rich, easily-handled, and fertile soils of the stream bottoms would ultimately need to be excluded from the project. Even were an extensive drainage system provided, many areas of the recent alluvial soils of the smaller stream valleys and coulee bottoms are too small to justify the additional expense and would be so critically subject to accumulation of seepage waters from adjacent higher-lying lands that it is believed they should be permanently dropped from consideration.

In addition to the soils of the three main groups as indicated above, a non-agricultural type of rough, broken and stony land has been mapped, the greater part of which had already been excluded from the project.

The individual soil types are indicated on the accompanying soil map by separate colors and symbols, and are described in greater detail in the following descriptions of soil types.

There would appear to be little reason to fear insufficient available plant food or an early exhaustion of any of the soils of the project under efficient cultural practices. The content of organic matter is low but could be maintained and increased by use of green manures. In a previous report on a general soil and agricultural survey of the Baker irrigation project by Prof. W. L. Powers of the Oregon Experiment Station application of sulphur is recommended, particularly in connection with the growing of alfalfa.

Samples of the various soil types recognized in this survey were taken for laboratory tests and for examination for content of injurious alkali salts, the location of such samples being indicated on the soil map.

Results of laboratory tests are given elsewhere in this report and all the types of soils are free from injurious amounts of alkali salts except those occupying low-lying areas subject to seepage and arrested drainage and now so recognized, the most of which have already been excluded from the Project.

Description of Soil Types.

Type No. 14.

Type No. 14 consists of a light brown or light yellowish brown surface soil of coarse gritty sandy loam or gritty loam texture, overlying a subsoil of practically the same color, but of more compact character and of gritty clay loam texture. At depths of 15 to 45 inches, with an average of about 30 inches, a granitic bedrock is encountered. Much coarse sand or fine quartzitic gravel is found in soil profile, the individual particles generally being of sharp angular outline. The surface soil has a relatively low organic matter content, and is loose and friable. The subsoil is moderately compact in the upper portion and usually within 6 to 8 inches of the overlying bedrock it is more friable with a larger per cent of coarse material consisting of partially weathered granitic bedrock. The soil has weathered in place from the underlying bedrock, only slight modification due to transportation having taken place in the vicinity of drainage ways. The soil material is noncalcareous.

The type is confined to the higher-lying areas on the north side of the Powder River. The largest area occurs just below the north side canal and lies between Tucker Creek and Clover Creek. A smaller area occurs between Clover and Balm Creeks. The type is inextensive, covering a total area of 563 acres as computed from planimetar measurements, of which 18 acres are indicated on maps furnished by the Bureau of Reclamation as lying at too great

an elevation to be covered by the proposed project. The more gentle slopes are well adapted to irrigation but much of the slopes is rather steep and will require skill and experience in handling water. Drainage is excellent throughout the extent of the type.

The native vegetation consists of sage and other low-growing desert shrubs and bushes. The land could be cleared at moderate expense and would require but little leveling or smoothing for irrigation.

None of the type is under cultivation at the present time, though two small areas have been utilized in time past in the production of grain without irrigation. While of rather shallow depth, its mellow, friable structure and prevailing southern slope would appear favorable to early crops. Possibly the type might prove to be adapted to the production of early hardy fruits or small fruits and vegetables should such prove feasible upon any of the soils of the project. Successful commercial production of fruits and truck crops has, however, not yet been adequately demonstrated, and these should be tried out experimentally before commercial plantings are made.

Type No. 24.

The surface soil of Type No. 24 consists of a rather heavy, sticky loam or clay loam, of a dark brown to dark reddish-brown color, extending to a depth of 6 to 10 inches. Much of it is, however, of gritty texture, containing an abundance of small angular particles of rock which imparts a granular, friable structure. A layer of rather compact dark brown clay loam or clay often occurs below this, and underlying parent bed rock occurs at a depth of from 6 to 20 inches, probably averaging about 12 inches. In some places much loose stone is scattered over the surface and through the soil.

The soil has been formed mainly by the weathering or breaking down in place of the dark colored basalt and associated rocks, some of which

contain considerable quartz and are of granular structure, particularly in the northern part of the project.

It is represented by a number of small widely scattered areas, mainly on the north side unit. It covers a total of about four hundred acres, of which nearly 100 acres lie above gravity water under the proposed project.

It occurs largely on the tops and upper slopes of knob-like hills, forming rather small and scattered areas.

The surface varies from gently to steeply sloping. Drainage varies from good to excessive. No alkali concentrations are found at the present time.

Practically hone of this soil is now under cultivation, as it lies above present irrigation ditches. It is covered by a good growth of sage brush, and a rather scant growth of small fine-leaved grasses. It is of some value as grazing land.

If irrigated, care will be needed to prevent erosion and waste of water on this land. The shallowness of the soil will no doubt tend to cause rapid drying out and necessitate frequent irrigation, though the soil itself is retentive of moisture where not too shallow. Clearing of rock will be essential to the preparation of much of the land for cultivation. The content of organic matter is low, but this could be supplied by growing of legumes and incorporation of organic manures.

Type No. 6.

The surface soil of Type No. 6 consists of 10 to 12 inches of a light brown, mellow, very fine sandy loam or silt loam. Water-worn gravels of mixed origin about 1 inch in diameter usually occur unevenly distributed through this horizon.

The subsoil consists of a horizon of light brown, slightly calcareous, medium compact loam to clay loam extending to a depth of 18 to 24 inches where it grades into a more granular, loosely-cemented gravelly silt loam layer containing a larger accumulation of lime. This horizon is underlain by rather impervious irregular layers or lenses of lime-cemented hardpan. This hardpan is usually encountered at depths between 20 and 30 inches but does not occur uniformly at these depths and is frequently exposed at or occurs near the surface. While in places it appears rather dense and may have a total thickness of three to five feet, it is usually rather fragmental and generally seems to consist of successive hard crusts or plates from one-half to an inch or more in thickness, with intervening layers of more fragmental or softer material. The harder layers are frequently fractured or of lenticular occurrence and the entire hardpan substratum may have a total thickness of only a few inches and appears to be penetrated to a greater or less extent by roots of native plants. It is, however, to be regarded as a distinct obstruction to percolation and subdrainage, and to development of crop roots, which will limit the effective water holding capacity of the soil and the yields and permanancy of deep-rooted perennial crops.

The presence and number of gravels varies through the entire profile and over the areas of this type. Some small areas are excessively gravelly and a few carry small amounts of basaltic stone of larger size, while adjoining areas are almost devoid of such material.

A large percentage of the gravelly and lighter-textured areas of this type occurs in the southwest portion of the project. The bodies mapped on the north side unit contain less gravel. The bodies of this type mapped

in the southeasterly part of the project tend to have heavy darker brown subsoil and are quite similar to type No. 17.

This type is derived from old valley-filling material of mixed origin, and occurs on the old higher benches. The south unit consists mainly of a high bench of this material that has been dissected by a number of small intermittent streams supplied mainly by the snow and rain waters of the higher surrounding region. This erosion has given rise to a series of small entrenched coulees and canyons leaving the high sloping flats as rather broad to long narrow bodies reaching from the margin of the project down toward the river. This type is also well distributed in rather irregular bodies through the north side unit.

Nearly all of this type has a smooth topography of slight to pronounced slope.

The drainage of the surface soil is good, while that of the subsoil is generally good but impaired by the hardpan that tends to arrest percolation. Some small areas having impaired surface drainage may occur following irrigation due to the uneven configuration of the hardpan. There are 7,486 acres of this type of which 580 acres are too high to be watered by gravity under the proposed project.

Because of the large extent and favorable slopes for irrigation, this is one of the most important types of the project. There is a small percentage of the type irrigated and under cultivation to alfalfa in the vicinity of Goose and Balm creeks. The remainder of the type is covered by a medium growth of sage about 18 inches in height, though in the southeastern part of the area where this type corresponds closely to the No. 17 type, the sage brush has made somewhat poorer growth.

The major portion of this type furnishes some grazing at present.

This soil is easily cultivated and irrigated. The surface soil will wash easily and care must be taken in the handling of irrigation water on the steeper slopes to avoid erosion and formation of gullies. The soil is uniformly low in organic matter and will be helped by agricultural practices that improve this condition. A crop rotation including alfalfa as the main crop should be practiced.

Type No. 11.

Type No. 11 has a smooth surface soil of light brown or light grayish-brown friable silt loam or heavy fine sandy loam texture, and generally extending to a depth of 6 to 12 inches. This is usually underlain by a subsurface layer of similar or of darker brown color and of more compact and often columnar structure, and which tends to be of heavier texture. A somewhat compacted light grayish brown deeper subsoil is usually encountered at a depth of 18 inches or more. In this nodules and seams of lime accumulation frequently occur and in some small areas an intermittent or fragmental to soft lime cemented hardpan is found. Here the type resembles Type No. 6 into which it frequently merges without distinctive lines of demarcation. In other localities the subsoil to a depth of six feet or more is not especially compact and does not contain sufficient lime to respond to the test with hydrochloric acid. In some localities the surface and upper subsoil are of comparatively recent formation, being composed of outwash from the adjacent high lying old valley filling soils. The deeper subsoil and sub-stratum, while usually consisting of old valley filling or old lake laid deposits, sometimes contain volcanic materials, and sometimes the more friable surface materials extend to the depth of six feet or more.

This soil is widely distributed in the area surveyed. It occurs in small and detached to larger connected areas of irregular outline. It occupies valley slopes and basin-like areas eroded in the upland terraces, the flats of which are occupied by Type No. 6 with which it is associated. The surface is generally fairly smooth and from gently to steeply sloping. The surface drainage is good to excessive. The subdrainage is usually good, though seepage from higher adjacent lands may come to the surface along the slopes under extensive irrigation of the higher lands. However, the type is practically free from seepage waters and alkali at the present time. The native vegetation consists of sagebrush and small fine-leaved grasses.

The type is extensive, covering an area of 7627 acres, of which about 120 acres lie above the proposed gravity system of irrigation.

It is not an important agricultural soil at present, only a very small proportion being under cultivation.

Small acreages of alfalfa and wheat have produced good yields, and a small amount of grazing is furnished by the grasses growing on the type, but much of it is so steep as to be of questionable agricultural value. (It is included largely under the B and C classes in the land classification).

Special care will be needed in irrigating this soil to prevent washing and waste of water, and small heads of water should be used. Land in alfalfa or grasses will not wash as badly as if used for grain or cultivated crops. Like the other lighter-colored soils of the region, it is low in organic matter, and may be improved by the growing of alfalfa or other leguminous crops and the plowing under of barnyard and green manures.

Type No. 15.

The surface soil of Type No. 15 is typically a friable silt loam, light brown to brown in color and in depth ranging from 6 inches to 20 inches or more. Variations of lighter and of heavier texture are included, however, which approach upon the one hand a very fine sandy loam and upon the other a silty clay loam. The subsoil is a somewhat compacted silt loam to clay loam, light grayish brown to light yellowish brown in color and usually noncalcareous or low in content of lime, though nodules or other accumulations of lime are sometimes encountered at variable depth, and small areas have thin layers of soft lime-cemented hardpan. Little or no gravel occurs in the soil or subsoil materials.

The soil material consists of comparatively recent old valley-filling deposits of stream-laid origin. It occupies the first terrace or bench above the recent alluvial bottoms, lying slightly higher than Types No. 2 and No. 4. It occurs as intermittent strips having an extreme width of about one half mile and bordering the river bottoms below the head of the valley. On the north side of the river the areas extend nearly to Clover Creek, while on the south side they occur nearly throughout the entire valley.

The surface is generally smooth and from flat to gently sloping. The surface drainage is generally fairly good. The subdrainage varies from fair to good at the present time, but in some localities the land will become affected by seepage when higher lands are irrigated. The type is practically alkali-free at present, except where it borders on Type No. 4 which is a similar soil with poor drainage and a high alkali content.

It is a moderately extensive type, covering an area of nearly 3000 acres. Under present conditions of agriculture it is one of the most important soil types of the area surveyed. The most of it is now irrigated

and producing alfalfa, small grains and pasture. Good yields of alfalfa and wheat are obtained, seasonal yields of 5 tons per acre for the former being reported.

Land of this type is easily worked and irrigated and is retentive of moisture. The organic matter content is low and the soil can be benefited by the growing of alfalfa or clover in rotation with other crops, and by the incorporation of organic manures.

While of present high relative importance in the economic agriculture of the region, owing to the fact that much of it is now more or less completely covered with water rights and under irrigation, this type is only partially included within the proposed project and is of less future comparative importance in this connection.

Type No. 17.

The surface soil of Type No. 17 consists typically of 7 to 10 inches of a light brown fine sandy loam or silt loam containing a few scattering water-worn gravels, overlying a dark brown compact heavy clay of somewhat columnar and adobe-like structure.

The deeper subsoil consists of a light brown or grayish brown compact clay which in so far as determined overlies an impervious substratum of cemented clay and gravel or of volcanic tuffs and ash. This occurs at somewhat variable depth, the average of which appears to be about 36 inches.

The type is derived from weathered old valley-filling deposits which appear to have had their source mainly in basaltic rocks. The gravels have been unevenly distributed throughout the soil profile and over the surface of the soil areas, and are mainly of basaltic origin.

This type occurs mainly as bodies of irregular outline on the high hills and slopes in the eastern end of the South Side Unit. One small area occurs on the North Side Unit near Goose Creek, and another occurs about midway between Tucker and Clover Creeks, while a few small areas appear in the extreme western part of the Project on the south side.

The type is inextensive and much of the slopes are too steep to be easily irrigated. The surface drainage is good while the impervious substratum retards the drainage of the subsoil, the water of which is held up and must drain off over the surface of this layer. The entire type is in virgin condition supporting a little grazing and a medium to poor growth of sagebrush.

While the subsoil is compact and intractable, the surface soil is friable and should be easily cultivated and pulverized.

Care must be exercised to prevent erosion in irrigation of the steeper slopes. Alfalfa or some other crop that tends to hold the soil from washing should be the main crop on this type.

Type No. 9.

The surface soil of Type No. 9 is composed of 10 to 18 inches of a chocolate brown heavy silty clay loam to clay loam or clay containing but a small quantity of organic matter.

The subsoil varies quite widely in different parts of the project. In the eastern part it is predominantly composed of a horizon of compacted, heavy, gritty clay loam or clay of columnar structure and of rich brown or dark reddish-brown color, extending to a depth of 26 to 36 inches where it is underlain by a rusty brown substratum of impervious cemented gravels and clay. This hardpan-like material is noncalcareous and apparently extends to a depth of several to many feet though in places it is replaced by beds of

volcanic tuffs and ash. In the middle and western parts of the project the subsoil is compact and heavy in texture, but the underlying impervious cemented hardpan-like material is less frequent or pronounced, and in much of the areas probably entirely wanting.

Small water-worn gravels are unevenly distributed over the surface and through the soil profile, being abundant in places and nearly wanting in others, and in some of the soil areas stone fragments of larger size and of irregular to water-worn outline are numerous.

This soil has been derived from weathered old water-laid deposits of mixed origin but in which basaltic materials are conspicuous.

This type occupies the tops and slopes of many of the ridges lying near the proposed main canal line and on the higher bench lands of the north side unit. Other bodies are mapped at the west end of the south side unit.

The surface of this type is smooth but has topography varying from gently sloping to rolling and hilly with steep slopes. While portions of this soil type would be easily irrigated, a large proportion is of pronounced slope and irrigation would be rather expensive and would require skill and experience in efficient handling of water. The topography of this type is such that drainage of the surface soil is well developed while that of the subsoil is impaired by the impervious substratum. The water moves through the subsoil above this impervious material and where the slope is sufficient there are no poorly drained areas. Under irrigation, however, seepage waters will tend to accumulate where the hardpan occurs at shallow depth along hill slopes and on adjacent lower lying lands.

About 4400 acres of this type have been mapped, of which 350 acres are too high to be watered from the proposed gravity system. A small percentage of this type is being cropped to alfalfa and average yields are reported. The remainder of the type supports some pasture grasses and a medium growth of sage brush.

This soil is sticky when wet and will clod up under tillage but should not be hard to pulverize when properly cultivated.

Great care will be necessary in handling of irrigation water on the steep slopes to prevent washing. A rotation in which alfalfa is the main crop is recommended.

Type No. 18.

The surface soil of Type No. 18 consists of a light brown, mellow silt loam which tends to be of light texture and includes some fine sandy loam material, and extending to a depth of 10 to 14 inches. This is usually underlain by material of similar or of slightly darker brown color, of silt loam or fine sandy loam texture, and which is slightly compacted. While this compaction is readily detected in typical areas, it is not always developed and the materials are always mellow and friable, very easily tilled, and readily permeable to water and plant roots.

This type, which consists of recent alluvial stream-laid deposits, is composed of somewhat variably textured, stratified sediments, but the subsoil is usually fairly uniform, consisting of light brown silt loam and and fine sandy loam materials of open, friable character. The surface soil generally contains a greater proportion of visible organic matter than the soils of the upland terraces, and the entire soil profile is free from indications of hardpan or of nodules or other accumulations of lime. Small waterworn gravels are of occasional occurrence and of irregular distribution

in the surface and subsoil materials.

Long narrow strips of this occupy the bottoms of the coulees and local eroded valleys traversed by small intermittent streams, which occur at intervals throughout the project. Other small areas occupy local alluvial fans, and alluvial flats and basins.

The surface of this type is smooth and gently sloping to nearly flat but many of the bodies are cut by narrow stream washes ranging from two to eight feet in depth. A body of about 35 acres of this type that is too stony to be of any practical agricultural value occurs about 3-1/2 miles southeast of Keating. This has been indicated on the soil map by stone symbol.

The drainage of the entire profile is well developed under natural conditions but, due to the position it occupies relative to the higher lands, much of this type will ultimately be subject to seepage and water-logging. Such areas are outlined on the land classification map and referred to further under that head.

There are 1368 acres of this type, of which a very small amount is under cultivation at the present time, but it is a rather important type due to the fact that in its present condition, it is a mellow, deep soil, early, is easily cultivated and handled, is productive and would be well adapted to irrigation. In its virgin condition this type supports a medium to heavy growth of sagebrush.

The cultivated area is being used mainly for the production of alfalfa.

This soil is adapted to the production of any of the crops grown in the area. Where the areas are protected from the waste and seepage waters of higher adjoining lands, some straightening of the stream channels would aid in preventing further erosion, and some good rotation of crops should be practiced. In the small unprotected areas some cropping may be practiced

until the land becomes affected by a high water table or alkali, when it may be utilized for pasture land. An agricultural program that will increase the organic-matter content should be practiced.

Type No. 35.

The surface soil of Type No. 35 consists of 12 to 18 inches of a dark brown, friable, heavy silt loam to silty clay loam. It generally contains a good percentage of organic-matter and there are some small included areas of high organic-matter content which are quite similar to muck.

The subsoil ranges from a rich brown to a dark grayish brown color, and to a depth of 36 inches or more is typically similar to the surface horizon in texture and structure. Areas having included strata of heavier texture, and some areas having small lime nodules in the subsoil occur in this type in parts of the Goose Creek bottom.

The type is composed of recent, stream laid deposits derived from mixed material but influenced by a high percentage of basaltic material. The muck-like areas are the result of the decay of vegetative growth along sluggish streams or swampy areas. The entire profile of this type is easily penetrated by roots and possesses a high-water holding capacity.

A large area of this type extending along Balm Creek is quite gravelly. The gravels are unevenly distributed through the soil profile, and in places decrease the ease of cultivation and the water holding capacity. Near the upper limits of the project this body is also quite stony, the stone being abundant and sufficient to materially lower the value of the land.

Areas of this type occur in long, rather narrow bodies along the main creeks of the north side unit. The surface is quite smooth and ranges in topography from nearly level to gently sloping.

With the exception of a few small areas occupying slight depressions or occurring adjacent to stream courses, the drainage is moderately well developed at present. The soil, however, has a high water retaining capacity, tends to be rather late, and the lower-lying areas occupy positions which will be subject to seepage and impaired drainage under extensive irrigation development on the adjacent upland slopes.

There are 1522 acres of this type mapped in the area surveyed, the larger percentage being under irrigation and cultivation at the present time. Crops raised consist of alfalfa, grains, pasture crops and vegetables. Excepting a few included heavy textured areas, this type is friable and easily tilled.

This is, under present conditions, one of the most fertile soils of the area and if properly handled in crop rotation, will give satisfactory results. This soil is not subject to severe washing and is one of the best soils of the area for growing row crops and vegetables. Conditions of topography and surface configuration are favorable to irrigation, but owing to existing partial or complete water rights, portions of the eastern areas of this type have been excluded from the proposed project.

Type No. 4.

Type No. 4 to an average depth of about 20 inches is a friable, light brown or light grayish-brown, heavy fine sandy loam to silt loam, often distinctly calcareous. The subsoil, which is of about the same color, is composed of stratified materials, mostly of fine texture. It is usually somewhat compacted and quite highly calcareous, and frequently contains small, soft nodules feebly cemented by lime and alkali salts, and small areas having thin, softly-cemeted hardpan layers were included under the type as

mapped. The soil material consists of comparatively recent stream-laid deposits of mixed origin which have been modified slightly by weathering and accumulation of lime and alkali salts and which approach in character of profile the old valley-filling soils.

This soil is found in rather small and scattered bodies lying along the outer edges of the river bottom lands, often closely associated with Types No. 2 and No. 15. It is low-lying and has a flat or gently-sloping surface. The surface drainage ranges from fair to poor. The subdrainage is usually poor and the soil is, with slight local exceptions, thoroughly impregnated with alkali salts. Most of the type was placed in the D class in the land classification. The native vegetation consists largely of salt grass and greasewood.

There were 1357 acres of this type of soil recognized and mapped, very little of which is under cultivation. It furnishes a scant growth of grasses and is utilized mainly as pasture. Owing to unfavorable conditions of drainage and alkali accumulation, the most of it has already been excluded by the engineers from the proposed project, and the type is of but little importance.

Only by drainage and the washing out of the excess salts can this type be successfully utilized for the growing of crops. It is probable that if more of the higher land is irrigated the drainage and alkali conditions will grow worse.

Type No. 2.

Type No. 2 has a surface soil of fairly friable, dark brown to dark grayish-brown material, typically a clay loam or silty clay loam in texture, though in places as light as a fine sandy loam. It is of high organic-matter content, and is often full of roots and of a mucky character. The subsoil is typically somewhat stratified though predominantly fine-textured.

It is somewhat lighter in color than the surface soil. Little compaction and no concentration or accumulations of lime are found in the profile. The soil material is distinctly micaceous and probably contains a large variety of rock material. It consists of recent alluvial deposits of the Powder River.

This soil occupies the first bottoms along the river. It forms an unbroken body extending throughout the entire alluvial valley of the Powder River.

The surface is flat. Surface drainage is fair to poor, and sub-drainage normally poor. The land is subject to occasional overflow in periods of high water. This, no doubt, accounts for the fact that much of the soil is practically alkali-free in spite of the presence of a high water table. The majority of the type is included under the D class on the land classification map.

This soil is fairly important agriculturally at the present time as compared with the other soils of the area. It is devoted largely to wild hay and pasture, though a small acreage of wheat was also observed. Wild hay yields 1 to 2 tons per acre. Many range cattle are pastured and fed during the winter. Owing to poor drainage and to danger of further accumulation of seepage waters and alkali salts, the greater part of the type has been excluded from the proposed irrigation project.

This soil is naturally very rich, but on account of the occasional overflows and the high water table is not well suited to crops other than native grasses. If much of the higher land is irrigated, the drainage and alkali conditions may become worse.

Type No. 45. (Rough, broken and stony land).

Rough, broken and stony land consists of land which is too steeply sloping, too irregular and rough, or too shallow or stony to be economically or successfully cultivated and farmed, either under irrigation or without.

In the present survey it consists mainly of steep slopes formed by erosion of the unconsolidated materials of the upland terraces. Areas of thin and stony soils underlain by basaltic and other rocks in which outcropping bedrock and steep rocky cliffs and canyons occur, are, however, included. These are most extensive and pronounced in the eastern and western parts of the south side unit. The most of the areas included with this type have been so classified mainly on account of steep and adverse topography, but a few areas occur, especially in the eastern part of the north side unit, in which the topography is not particularly unfavorable to cultivation and irrigation but in which the soils are shallow and exceedingly stony.

The type is extensive, covering an area of 9101 acres. It is scattered throughout the greater part of the area surveyed but is most extensive on the south side unit.

The type has already been practically entirely excluded from the project by Bureau of Reclamation engineers.

A rather scant growth of grasses is found on much of the type, which is of some value for grazing, being utilized mainly for grazing of sheep, but otherwise the type is of no agricultural importance.

The areas of the various types of soils computed from planimeter measurements with the relative percentages which they bear to the total area surveyed are shown in the following table:

Areas of the Various Soil Types.

Soil Type.*	Areas acres	High Areas acres	Percentage of total.
No. 14	564	18	1.39
" 24	394	97	.86
" 6	7487	580	18.45
" 11	7627	119	18.81
" 15	2971	00	7.32
" 17	711	187	1.75
" 9	4391	351	10.83
" 18	1367	00	3.36
" 35	1522	00	3.93
" 4	1357	00	3.34
" 2	3052	00	7.55
" 45	9102	00	22.43
Total	40545	1352	100.00

* Exclusive of area east of Goose Creek, which has been excluded by the Bureau of Reclamation.

Land Classification.

The land classification survey conducted in connection with the soil survey of this project, has for its purpose the presentation of the salient conditions of topography of the land as related to steepness of slope and surface configuration. Owing to complexity in occurrence and distribution of the soils of variable topography, it seemed necessary that there be in addition to the soil classification based upon the soil type, some effective method of delineating and presenting the facts as to topographic features of the lands included within the project as related to efficiency in application and distribution of water.

The land classification map, therefore, is concerned less with the agricultural features of the project as measured by crop production and more with the phases of irrigation development as related to cost, efficiency and hazards in the application and distribution of water.

Had the soils of the project been of simple occurrence and limited to fewer types, occupying more extensive areas, consideration of soil and land classification might have been combined in a single map. Under the circumstances it has appeared expedient that the latter be handled as an independent unit in the survey. For the purposes of delineating the conditions desired upon the land classification map the lands have been classified into 6 grades or classes each of which is represented by distinct color and symbol in the land classification map, as follows:-

A - Irrigable Lands, First Class.

The areas designated as irrigable lands of the first class have a smooth surface configuration free from pronounced ridges, depressions, or wind-blown hummocks which would add to expense of preparing for irrigation. They occupy areas of gentle to moderate slope sufficient to favor ready distribution of water but not such as to readily promote injury by erosion or to call for unusual labor or expense in construction of distributing systems and in irrigation practice. The lands of this class are favored by good surface drainage though subdrainage is restricted in the more elevated hardpan areas, and it is possible that some of the lower-lying areas of the stream valleys may in time become adversely affected by seepage waters arising from extensive irrigation of the uplands. Development of any considerable water logged or alkali-affected areas is, however, not believed imminent under irrigation of the project. Land of this class

occupies nearly 7,000 acres, of which about 270 acres are too high to be reached by gravity water. The larger areas occupy the lower terraces and slopes of the river valley, intermediate in position between the low-lying alluvial lands and the dissected higher benches from which they are usually separated by a distinct escarpment. Other conspicuous and widely-distributed areas of irregular outline occupy the upper flats or uneroded remnants of the higher upland terraces lying between incised drainage courses or areas which have been dissected or rendered irregular by erosion. Other areas of local occurrence occupy alluvial fans and portions of the valleys of some of the larger creeks of the north side unit. The lands of this class constitute the most desirable and important lands of the project.

B - Irrigable Lands - Second Class.

Second class irrigable lands consist of areas of moderately pronounced slope in which efficient distribution and application of water will be effected with some difficulty and expense. The surface is usually smooth and but little levelling will be required. The slopes are, however, such that some care will be necessary to prevent erosion, and skill and experience will be a decided asset to the settler.

Drainage is well developed and injury from seepage or alkali accumulation will probably be relatively insignificent and localized, and limited to occasional small spots which may be affected by local hillside seeps.

The lands of this class occupy an area of 6382 acres, of which about 400 acres lie above the reach of gravity water under the project. The irrigable areas are of irregular outline and usually scattered throughout the north and south side units. They occur mainly in the more steeply-sloping parts of the upland terraces and in the more gentle of the eroded slopes marginal to the coulees and entrenched stream valleys.

The second class lands are capable of growing alfalfa and general farm crops by careful cultural practices, but conditions of slope and contour would probable be better adapted to fruits or other intensively cultivated crops should such prove possible under prevailing climatic conditions.

While inferior to the lands of the "A" or first class, inclusion of these lands is not incompatible with the successful irrigation of the project, providing the cost of the water is sufficiently low to be economically feasible.

C - Irrigable Lands - Third Class.

Class "C" lands, recognized as third class irrigable lands, occupy the steeper slopes on which irrigation is physically possible but difficult and expensive in time and labor necessary to efficient handling of the water. The surface is usually smooth and but little levelling is necessary, but care will be required to effect uniform and efficient irrigation and in avoiding erosion. The latter will constitute a grave problem in land of this class and such areas should be placed in the hands only of settlers giving evidence of skill and experience in irrigation. Wholesale attempts at irrigation of class C lands by inexperienced or careless settlers could result in hardly else than a calamity.

Land of this class occupies a total area of slightly more than 10,000 acres, of which about 480 acres lie too high to be watered by the proposed project. The areas are usually widely distributed but are most extensive on the north side unit. They are recognized as better adapted to special intensively cultivated crops, though alfalfa and grains can be, and are in some localities now being grown under irrigation by a few exceptionally

skilled and experienced farmers. Whether this can be economically accomplished on an extensive scale is, however, questionable and will be determined largely by the cost of water and of necessary farm equipment and operations, the discussion of which forms a separate part of this report.

D - River Bottoms, Poorly Drained.

Class "D" land occupies the bottoms of Powder River. It is of flat surface. Most of it is more or less water logged and of high water table and portions adjacent to the river channel are subject to overflow during times of flood. Heavy accumulations of alkali occur upon portions of the area covered though the greater part which occupies the lower bottoms adjacent to the river is free from excessive alkali accumulations. Drainage conditions are unfavorable to inclusion of the lands within the proposed project and such as to cause more pronounced and more extensive waterlogging and accumulation of alkali under extensive irrigation development of the uplands.

Class D land occurs mainly as a continuous area extending throughout the Powder River Valley. Two or three small isolated areas occur in the bottoms of Clover and Goose Creeks. It covers a total area of 4340 acres.

While of considerable importance in the present agriculture, being utilized for pasture and the production of wild hay, it has practically all been excluded from the proposed project by the Bureau of Reclamation on account of unfavorable drainage and alkali conditions and is of little importance in this connection.

E - Local Bottoms - Impaired Drainage.

The lands of Class "E" occur mainly in the bottoms of the creeks and local coulees and drainage courses. Small additional areas occur along

the slopes of the river valley. They are of gently-sloping to nearly-flat surface and usually smooth and favorable to irrigation under present conditions, though small areas occur which are somewhat uneven or cut by transient drainage channels which carry water only at irregular and infrequent intervals.

Class E lands occupy a total of about 2500 acres. The individual areas are of variable extent, irregular outline and are widely distributed throughout both the north and south side units. With the exception of but one or two localities they are free from injurious accumulations of alkali. Both surface and subsoil drainage are well developed under present conditions, but the areas occupy low-lying localities favorable to accumulation of seepage waters and alkali under extensive irrigation of the adjacent higher slopes and uplands. Some of the areas could be protected by drainage channels so situated as to cut off seepage from above, but they are for the most part small and narrow and insufficient in extent to bear the cost of drainage in addition to the water charges under the project.

The areas of Class E lands have been indicated on the map in localities in which field judgment would indicate conditions of impaired drainage would be most imminent under irrigation of the project. They could, however, probably be utilized under irrigation for some time, both soil and topographic conditions being favorable. It is believed, however, that ultimately most of these areas would become affected by seepage waters and alkali and that the exclusion of most of the areas from the project should be considered.

R - Non-irrigable Lands.

The lands of the "R", or non-irrigable class, occupy steep slopes and areas of irregular topography which are unsuited to permanent or economical irrigation. While irrigation is physically possible in some of the areas

included under this class of lands, conditions of topography are adverse and such as would render cost and labor involved excessive, water difficult of control, and danger of excessive erosion grave.

Class R land covers an aggregate of about 10,000 acres. It occurs as areas of irregular outline widely scattered throughout the project. These areas are of some value for grazing purposes but it is recommended that they be eliminated from consideration under the irrigable lands of the project. The steeper and more pronounced areas have already been excluded by the Bureau of Reclamation engineers.

The extent of the various classes of land as indicated on the land classification map and as determined by planimeter readings is shown in the following table:

Areas of Land of Various Classes

North Side Unit

(2) Class	Area, in acres*	(1) High area, in acres	Irrigable area, in acres
A	3322	203	3119
B	2995	115	2880
C	6222	407	5815
D	1933	---	---
E	1559	---	---
R	3316	---	---
Total North side	19347	725	11814

South Side Unit

A	3656	67	3589
B	3387	284	3103
C	3945	72	3873
D	2407	---	---
E	1024	---	---
R	6779	---	---
Total south side.....	21198	423	10565
Grand Total:	40545	1148	22379

* The areas indicated under the North Side Unit are exclusive of lands lying east of Goose Creek, which are shown on accompanying maps but which

have been excluded by the Bureau of Reclamation from the project subsequent to the preliminary surveys.

(1) The High areas indicated in the second column of these tables represent areas lying above reach of gravity water which have been excluded by the Bureau of Reclamation. The total of the high areas does not check with that of the high areas indicated under table showing areas of soil types on page 43. This apparent discrepancy is due to the fact that some of the high areas of certain soil types have been included under the nonirrigable(R) class of land owing to adverse topography.

(2) Certain irrigated areas under Classes A, B and C have also been excluded from the project by reason of present water rights. Class D may include small areas and Class E is wholly or mainly included under the project as proposed, and the lands of Class R are in part included.

Crop Map.

Upon the crop map accompanying this report is indicated the utilization of the land or crops grown at the time the survey was made. Reference to the map indicates the lands of the valley to be utilized at present mainly for pasture and wild hay, and for alfalfa which is grown under irrigation. These phases of agriculture are conducted mainly in connection with dairying and the raising of live stock, mainly cattle and sheep. The lands devoted to pasture and wild hay are mainly those of poorly established drainage occupying the lower-lying areas of the river bottoms. The alfalfa lands occupy the somewhat better-drained lands of the river valley and of some of the north side streams. Wheat and other small grains are grown to a limited extent partly without irrigation. A few small areas which have been cleared and in part planted to grain crops have been abandoned, and there are a few small areas of a few acres each utilized for potatoes, vegetables and for orchard. The latter are mainly planted to apples but there has been but little attempt made to grow fruits on a commercial scale and it is as yet doubtful whether commercial fruit production would be possible on the lands of the project.

While future development of agriculture may include introduction of fruits or other specialized crops, it is felt that such more or less remote possibilities can not be capitalized under present conditions and that the feasibility of the project should be decided on the merits of the lands as adapted to present proven farm crops and farming systems.

Resume of Soil and Land Classification.

The Baker Project covers the greater part of the Lower Powder River Valley in Baker County, Oregon. It covers an area having a maximum width of about seven miles and extending through a distance of about 16 miles, and which is nearly equally divided into two units by the Powder River.

The general topography of the project is strongly sloping to rolling, steep and dissected.

The soils of the project are derived from a variety of materials and are represented by a number of distinct types, which differ materially in origin, topography, depth, character of subsoil and other underlying materials.

Some of these are derived in place by weathering from consolidated rocks consisting mainly of basaltic rocks, green-stones, and rocks of granitic character. These represent the residual soils of the survey. They are of rolling and hilly topography and well drained. They are frequently shallow or stony and are of minor extent and importance in the Project. They are represented by Types arbitrarily designated as Nos. 14 and 24.

Others, which constitute the predominating soils of the project, are derived from weathered and modified old unconsolidated deposits of the valley terraces. They have had their minerological origin in a variety of rocks, and the parent materials have been accumulated through the agencies of

running waters, winds, and by deposition in former lakes. They are characterized by subsoils which are of heavy texture or which include compacted or cemented hardpan-like layers or horizons, or fragmental or nodular materials of calcareous character. They vary in topography from smooth and gently sloping to steep and eroded. Surface drainage is well to excessively developed but subdrainage is frequently restricted. These are represented by the old valley-filling soils.

The most extensive and important types of these are designated as Types 6 and 11.

Type 6 occupies the more elevated uneroded flats or surfaces of the terraces. It is of mixed origin, light color and is characterized by compacted subsoil having one or more layers of lime-cemented hardpan. These are of variable thickness, and constitute a distinct obstruction to penetration of irrigation water and development of roots. It is, however, more or less fragmental and appears to be penetrated by roots of native plants and can be irrigated and farmed. Topographic conditions are generally favorable to irrigation and drainage though the type includes some areas of steep lands which should be excluded. It is one of the most extensive and important types of the project.

Type 11 occurs typically about the eroded slopes and local basins occurring in the upland terraces, the flats of which are occupied by Type 6. Hardpan is usually fragmental or absent and general conditions of the soil profile are somewhat more favorable than is the case with Type 6. The topography is, however, more irregular and eroded and a considerable proportion of this type should be excluded because of steep and rough slopes.

Type 15 is a light-colored soil of very fine sandy loam and silt loam texture, friable, easily cultivated and handled and retentive of moisture. It occupies the lower terraces adjacent to the alluvial bottom lands of the valley and has a slightly cemented or compacted subsoil without consistent or pronounced hardpan. It is of smooth topography and well adapted to irrigation but will in part be subject to injury from seepage and alkali accumulation under extension of irrigation.

Type 17 is a light colored silt loam soil having compact heavy-textured darker-colored subsoil resting upon indurated clay-like materials or volcanic tuffs. It is usually of shallow depth, rolling to sloping topography and of minor importance though capable of irrigation.

Type 19 is a brown to dark brown soil of heavy texture, having heavy compacted subsoil or noncalcareous cemented hardpan or substrata of volcanic tuffs. It is retentive of moisture and would be productive under irrigation where of favorable depth but is frequently stony and shallow, in places is of steep topography, and is of only moderate extent. Surface drainage of this type is well develcped to excessive.

The recent alluvial soils are of recent deposition and occupy the stream bottoms. They are of smooth topography and usually deep, friable and productive. Unfavorable conditions of drainage and alkali accumulation, however,occur, and other areas will become subject to injury from alkali and seepage waters under extensive development of irrigation in the uplands. Where favorable drainage conditions can be maintained, they will constitute productive soils which can be easily handled and which will be retentive of moisture and well suited to irrigation. Of these types Nos. 35 and 18 occupying the creek and coulee bottoms are probably intrinsically the most

fertile soils of the project. Types No. 4 and 2 which occupy the river bottoms are of flat topography and the most of these types have been excluded from the project previous to this survey on grounds of a high water table or alkali content.

Rough, broken and stony land occupies areas which are too steep or rough in topography or in which the soils are too shallow or stony to be suitable to agriculture. It is extensive but of no agricultural importance and has practically all been excluded from the project previous to this survey.

With the exception of the type of rough, broken and stony land, the soils of the project can be irrigated and farmed where topographic conditions are favorable to irrigation and drainage. Conditions of topography are, therefore, of primary consideration in connection with the study of soils in this survey, and in assigning the place which any soil type or types can be expected to assume in the development and maintenance of agriculture, and the lands of the area surveyed have been further segregated into six classes, based upon conditions of topography and drainage.

Class "A", irrigable lands, first class, are of smooth surface, gently to moderately sloping, and well adapted to irrigation. They occupy an area of about 7,000 acres.

Class "B", irrigable lands, second class, occupy areas of somewhat steeper slope and are capable of irrigation with somewhat greater difficulty. Irrigation will be more laborious and expensive and some care will be necessary to prevent erosion. Land of this class covers an area of about 6,400 acres.

Class "C", irrigable lands, third class, occupy steep slopes and areas of irregular surface. Irrigation will be expensive and will require close supervision and great care will be necessary to prevent erosion. Irrigation of these lands upon any extensive scale should be attempted only by settlers having experience and skilled in irrigation practice. This class of land covers an area of more than 10,000 acres.

Class "D" lands, occupy areas of river and stream bottoms of flat surface and in which drainage is poorly developed at the present time. Much of the areas are already waterlogged and areas of excessive accumulation of alkali occur. They cover an area of 4340 acres and have mainly been excluded from the propcsed project previous to this investigation.

Class "E" lands occupy local stream bottoms and valley slopes, at present well drained and adapted to irrigation, but in which drainage will become impaired under extensive irrigation of the uplands. They are of doubtful value and would best be eliminated from the permanent lands of the project. They cover an area of about 2,500 acres.

Class "R" or nonirrigable areas, occupy an area of about 10,000 acres. Owing to excessively steep slopes or to irregular surface and to resulting high cost and difficulty in irrigation, waste of water, and to danger of erosion, it is recommended that they be excluded from the project.

The lands of the area included within the survey which are at present utilized for agriculture are confined mainly to the bottoms and low terraces of the river and the larger tributary streams. Small areas of the higher bench lands are farmed in the eastern part. The most of these lands are now under present partial or complete water rights and some of these areas have in consequence been excluded from the proposed project by the Bureau of Reclamation.

A large proportion of the lands now in farms is utilized for pasture and the cutting of wild hay. The irrigated lands are utilized mainly for alfalfa, and small grains are grown to a limited extent.

While commercial growing of fruits or other special crops is a possibility this has not yet been demonstrated, and the feasibility of the project should be determined on the basis of proven farm crops and farm practices.

LAND OWNERSHIP AND LAND HOLDINGS.

The soil survey shows a gross area of about 40,000 acres between the canal lines and the river. Of this about 18,000 is public land. The distribution of the public and private land is shown on Map No. 1. The location of the public land was taken from the records of the local land office at La Grande, Oregon, while that of the private land was taken from the assessment roll of the Lower Powder River Irrigation District for the year 1922. There were a few conflicts between the two lists, but the entire area involved was only 80 acres, and this can be disregarded. There is a small area of state school land that is classed as private land, since it is subject to purchase rather than to homesteading.

The Lower Powder River Irrigation District, as organized, includes land under a proposed high line canal that is not included in the project as outlined in the Reclamation report. The land ownership within the present project was determining by checking the land descriptions given in the assessment roll on the map showing canal locations. Considerable parts of the land under the canal lines have been eliminated from the project because of being too high, too rough, too steep, or too wet, but

in this discussion these eliminations are disregarded, except as noted otherwise.

On the assessment roll there are listed 76 tracts of land that fall within the project as it stands. In many cases several tracts that in fact form a single ranch are listed separately in the names of different members of the same family, and many of the tracts are undeveloped, so that the number of ranches in the project is much less than the number of tracts listed on the assessment roll.

Taking the figures from the assessment roll, there is but oneholding of less than 40 acres, and but one other as small as 40 acres; there are nine holdings of from 41 to 80 acres; twenty-five of from 81 to 160 acres; and fifteen of from 161 to 320 acres. Of the remaining holdings seven exceed 500 acres, and three exceed 1,000 acres. The average holding exceeds 200 acres.

Assuming that, if this project is approved, the Secretary of the Interior will fix a size for farm units and require the present land owners to agree to reduce their holdings to the size fixed, the condition with farm units of different sizes will be as follows: With 160-acre farm units 40 of the present holdings will have to be subdivided; with 80-acre farm units 65 holdings will be subdivided; and with 40-acre farm units all but two of the present holdings will be subdivided.

Taking the holdings as they stand, the number of settlers required for the private land to conform to farm units of different sizes will be as follows: With 160-acre units 59 settlers; with 80-acre units, 152 settlers; and with 40-acre units, 352 settlers.

Exclusions, for the reasons stated previously, will reduce these numbers; but the fact remains, that under any probable farm-unit size,

most of the existing ranches will have to be subdivided, and settlers brought in.

All of the public land, of course, requires settlement. If this were all irrigable it would require 113 settlers with 160 acre farm units; 226 settlers with 80-acre units; or 452 settlers with 40-acre units. As is the case with the private land, the public land is not all irrigable, and the number of settlers required will be considerably less than given here.

The distribution of the public and private land in the land classification made in the soil survey, is given in the following table:

Distribution of Public and Private Land
Among Classes of Land.

Class	Total	Public 45%	Private[1] 55%
Gross area.	40,545	18,224	22,319
Deductions:			
River bottom, poorly drained	4,340	0	4,340
Local bottom, impaired drainage	2,583	310	2,273
Steep, rough, rocky and high	11,244	7,659	3,585
Total deduction	18,167	7,969	10,198
Irrigable:			
First class	6,707	1,475	5,232
Second class	5,982	3,220	2,762
Third class	9,687	5,560	4,127
Total irrigable	22,376	10,255	12,121

(1) Obtained by subtraction.

As shown by the table, 45 per cent of the total area is public land, and about the same percentage of the irrigable area is public land. Deductions from the private land are due largely to poor drainage, while those from the public land are due to steepness, roughness, etc.

LAND VALUES.

Present values of land in the Lower Powder River Valley are difficult to determine because of the fact that under present agricultural conditions

there is little market for land, and consequently there are few sales by which to judge values.

Assessed values of the lands within the project were taken from the records of the county assessor. Here, as in other discussions, the eliminations of land for various reasons are disregarded because these eliminations have no relation to property lines, and on the assessment roll the area in each tract is divided between "tillable" and "non-tillable", without describing the boundaries of each class. It was not possible either, to divide exactly the holdings that lie along the canal lines. Consequently the areas given below are approximate, but the averages represent correctly the assessed values of land within the project.

The assessed value of private land is given in the following table:

Assessed Value of Land in Proposed Baker Project.

Item	All private land.	Tillable land.	Non-tillable land.
Area of land (acres)	15,679	4,934	10,745
Value of land	$249,135	$212,070	$37,065
Average value per acre	$15.89	$42.96	$3.45
Maximum value per acre	$75.80	$75.80	$28.00
Minimum value per acre	$ 2.08	$ 6.00	$ 2.08

The land is supposedly assessed at full value, and it was not possible to get definite statements from officials as to the real basis of assessments. A common statement is that the land is assessed at 60 per cent of its value. Assuming this to be true, gives the following values: Average for all land $26.50 per acre; average for tillable land $71.60 per acre; average for

non-tillable land $5.75. It is evident that "tillable" land is in fact tilled land, and the classification used by the assessor has no relation to the quality of the land.

The directors of the local farm loan association at Baker gave the following values for land in the territory under consideration: Good alfalfa land, $100 per acre; salt grass land in the river valley, $5 per acre; sage brush land, $5 per acre; land in the creek valleys about the same as in the river valley. The board does not recommend loans on dry-farm land. These values are not inconsistent with those obtained by assuming that the assessed value of land is 60 per cent of the full value. The "non-tillable" lands on the assessment roll, which have an average value of $5.75 are principally salt-grass pasture or sage-brush hillsides, valued at $5 by the farm-loan board.

A canvass of farms in the district showed that a large part of the land had been in the present ownership for many years, but several of the farms had been purchased within recent years. The dates of purchase and the prices of farms in the river valley for which statements were obtained were as follows:

Purchase Prices of Farms in Lower Powder River Valley.

Farm	Date of Purchase	Acre	Price	
			Total	Average per acre
1	1922	172	$13,000	$75.58
2	1916	160	10,000	62.50
3	1917	352	20,000	56.82
4	1918	80	6,500	81.25
5	1918	240	15,000	62.50
Total	----	1004	64,500	64.24

All these farms are located in the river valley and contain some of the best alfalfa land in the project, and have dwellings and other improvements on them. All except the first one were purchased during the period of agricultural inflation, and the prices evidently are much greater than those now current.

In the following table the assessed value of the same farms in 1922, is compared with the purchase price:

Comparison of Assessed Value and Purchase Price.

Area	Purchase Price		Assessed Value		
	Total	Average per acre	Total	Average per acre	Percent of purchase price
172	$13,000	$75.58	$4710	$27.38	36.2
160	10,000	62.50	4520	28.25	45.2
352	20,000	56.82	9170	26.05	45.9
80	6,500	81.25	2600	32.50	40.0
240	15,000	62.50	6820	28.42	45.5
1004	64,500	64.24	27820	27.71	43.1

Assuming, as before, that the assessed value is 60 per cent of the actual value, the present value of these lands is $46.18, or a decrease of about 28 per cent since the dates of purchase.

MORTGAGES.

The farms in the Lower Powder Valley are generally mortgaged. The directors of the local farm loan association made the general statement that there are very few farms that are not mortgaged to the limit. This item was covered in a farm survey of nineteen farms. Of these, fifteen reported mortgages and four reported no mortgages. Several farms not included in this survey were in the hands of banks that had foreclosed mortgages.

Comparing the assessed value of farms with mortgages on real estate for nine farms for which this is possible from the data available, shows mortgages aggregating $70,000 on property assessed at $51,810; or that the mortgages are 135 per cent of the assessed value. In many instances there are chattel mortgages also.

This situation is important because of the heavy interest charges that must be met by the land owners who are proposing to assume the responsibility of repaying construction charges.

In the discussion of the size of present private-land holdings it was shown that it will be necessary to subdivide many of the existing farms, to conform to the Reclamation law and the farm-unit size that may be adopted by the Secretary of the Interior. In many other projects there has been a tendency for land owners to hold their land for prices that settlers can not afford to pay. To overcome this, attempts have been made to secure agreements from land owners to sell their surplus land at agreed prices. No such agreements have been obtained from the owners of land in the Baker Project. On the basis of present values, settlers would have to pay about $100 per acre for good land in alfalfa, about $70 per acre for improved land generally with full or partial water rights; and about $5 for unimproved land, most of which is in sage brush.

Public land is obtained for the land-office fees, which amount to little, but it is probable that the miscellaneous expense connected with obtaining public land will amount to about the same as present prices of unimproved private land. If the selling prices of private land conform to present valuations, there will be little choice between homesteading and purchasing unimproved private land.

Most of the improved private land is in the class requiring stored water only, and the purchase price of such land will be more than offset by decreased construction charges, making it preferable to either the public land or the unimproved private land.

In obtaining settlers the Baker project will meet competition from (1) other raw lands, and (2) lands already in cultivation. It is difficult to anticipate the condition that will exist when this project is completed, if construction is undertaken. At the present time there is little demand for raw land, with large areas available in existing projects, and a great deal of improved land throughout the West, as well as elsewhere, is for sale at prices considerably below the estimated construction cost on the Baker project.

IRRIGATION DISTRICT.

The Reclamation report recommended that the project be given favorable considerable provided, among other things, "that a satisfactory contract be made with the Lower Powder River Irrigation District, providing for repayment of the cost and prorating the cost of examination and surveys and storage on an acreage basis to all lands included in the project".

The irrigation district referred to included not only the lands in the project as it stands, but also lands under a proposed high line canal that is omitted from the present plans.

Under date of October 11, 1922, the board of directors of this irrigation district passed the following resolution:

> "Be it resolved by the board of directors of the Lower Powder River Irrigation District that said board favors the said district assuming a construction charge for storage to be assessed equally per acre against all district lands based on the maximum cost stated in the Reclamation Service Board report of July 3, 1922, and approves as feasible said board's estimate of canal and lateral construction".

This action of the district board is given as showing the attitude of the land owners toward the construction of the project. It should be noted that the district as constituted includes a large area not within the limits of the project as recommended and that the resolution relates to other estimates than those reported by the board of engineers. Of 143 tracts of land shown in the assessment roll of the district 63 are outside the project as now planned. It should be noted further that 45 per cent of the land in the project, after all eliminations are made, is vacant public land and those who will be called upon to make the payments of cost apportioned to these lands have not been represented in the organization of the district and will not be represented in passing upon any contract submitted to the voters of the district.

In another section of this report attention is called to the fact that not only the public lands but a large part of the private lands will have to be colonized if the law limiting the area in a single ownership to which water may be supplied is enforced. The prospective owners of this land, also, will not be represented. It appears, therefore, that any contract made by the present land owners, organized as the Lower Powder River Irrigation District, will not represent those who are to make the payments covered by the contract.

Another phase of the district situation that should be given consideration is the fact that until the public lands are taken up there is no way in which they can be made to contribute their share of the cost of either construction or operation and maintenance.

Under the usual form of contract between the Department of the Interior and irrigation districts, it is provided that a district is not obligated to

pay the part of the construction cost apportioned to public land until the land is entered. The Federal irrigation district act (Act of Aug. 11, 1916) provides that operation and maintenance charges may be levied against unentered public land, but the Government is not obligated to pay these charges; rather, they accumulate as a charge against the land, to be paid by the entryman when he applies for the land. In the meantime the amount assessed against these lands and unpaid must be assessed against the private land and the entered public land. Present land owners should realize that their land will be liable for whatever payments fall due, and particularly may have to carry the load apportioned to the public lands for operation and maintenance for an indefinite period.

While the area of public land is only 45 per cent of the total area, the fact that much of the private land is charged with payment for only a partial water right, leaves more than 50 per cent of the cost chargeable to the public land, but likely to be shifted to the private land on account of the public land not being liable for district taxes until it is entered.

Since the charge on the land under the estimates is so high that there is doubt as to the land being able to carry it if every acre carries its own load, a contract with the district constituted largely of public land, as is this one, is no assurance to the Government that the cost will be repaid; and, on the other hand, the original apportionment of the cost as between public and private land, gives no assurance to the land owner that his liability will be limited to the amount originally apportioned to his land.

Under the conditions existing in the Lower Powder River Valley, some other form of organization than the irrigation district should be

devised, in justice to both the Government and the land owners, both present and prospective.

TRANSPORTATION.

The Lower Powder Valley, in which the project is located, lies to the northeast of the city of Baker, the distance by highway being from fifteen to twenty-five miles, with an average of about 20 miles.

A fairly-well surfaced state highway leads from Baker to the center of the project and to the lower end. This highway passes over a ridge that separates the Lower Powder Valley from the Baker Valley, the high point on the highway being about 1000 feet above the lower end of the project, and about 300 feet above Baker. A more direct highway leads from Baker to the upper end of the project. On this the high point is lower than on the other road, while the irrigable land is higher, so that the elevation over which the products grown in the valley must be hauled is considerably less. This road is not now surfaced, but an appropriation for that purpose has been made. The products of the Lower Powder Valley that are to be shipped must be hauled an average distance of twenty miles, over a ridge from 800 to 1000 feet higher than the valley, to reach a shipping point. There are stages that haul cream, and other small freight from the valley to Baker. The farmers of the valley reported paying from 40 cents to 50 cents per five-gallon can of cream for this service. The same amounts represent the range in prices received per pound of butter fat.

This long, difficult haul places a heavy handicap on the growing of any bulky products of low unit value that are to be shipped out of the valley, and, added to the railway freight charges, preclude the inclusion of such products in the agricultural program of the valley.

Most of the agricultural products of this section are shipped to the Pacific Coast markets. In railway freight rates this section has an advantage over other producing sections further east, but is at a disadvantage over sections nearer the coast. The long haul to the railroad would tend to off-set the advantage in freight rates over Idaho points.

There is talk of the construction of a logging railroad through this valley, but no assurance that it will be built.

TYPE OF AGRICULTURE:

The type of agriculture for any district is dependent, among other things upon the soil, climatic, and marketing conditions. In this district there is at present a lack of local transportation that has influenced this type of agriculture.

There has been developed in the Lower Powder Valley a form of live stock and limited dairy farming. The irrigated lands are devoted to the growing of alfalfa hay and salt grass pastures and a very limited amount to grain.

The flocks and herds are pastured on the open public lands and the national forest during the spring, summer and early fall. They are pastured for a limited time in the fall upon the farm lands and then fed alfalfa and straw during the winter.

The dairy cows are pastured on the salt grass pastures and fed alfalfa hay. In a canvas of many of the farms now in operation in the Lower Powder Valley there was not a single instance noted where dairy cattle received a ration of grain, roots or ensilage.

The soils are fertile and well adapted to any crops permissible in this climate, excepting where the light colored subsoil or clay comes too near the surface.

The following meterological data for Baker City, which correspond very closely to those of the Lower Powder Valley, will give the important limiting factors in crop selection.

Meterological Data for Baker Project, Oregon.

Temperature

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean	25.7	29.6	36.6	44.5	51.5	57.9	66.1	65.6	56.4	47.2	36.7	27.7	45.4
Mean Maximum	32.7	37.1	45.4	55.6	62.9	66.3	78.1	78.2	67.6	57.6	44.0	33.7	46.4
Mean Minimum	18.0	21.6	27.6	33.7	39.7	45.2	49.0	44.9	40.7	33.6	27.2	20.3	34.5
Highest	55	59	74	83	88	97	102	101	94	85	66	58	102
Lowest	-14	-20	-12	15	24	27	36	31	23	12	-8	-24	-24

Precipitation

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Maximum	2.04	2.59	1.40	0.37	1.37	2.59	1.83	0.43	0.14	0.16	1.31	4.00	18.23
Minimum	1.93	0.43	0.62	0.38	0.02	0.19	1.12	0.92	0.53	0.71	0.56	0.30	7.71
Average	1.27	1.19	1.19	0.99	1.47	1.20	0.58	0.48	0.76	0.82	1.00	1.31	12.26

Frost Data

	Year	Frost free period No. of days
Minimum	1895	81
Maximum	1914	185
Average for 30 years	--	135

It is stated locally that the growing season in the Lower Powder Valley is slightly longer than that at Baker, probably an average of 150 days.

A general survey of the above data indicates that only the hardier plants may be expected to yield a good crop every year.

The frost-free period is not usually sufficiently long for apples. There are now within the district a few apple groves of from 1 to 3 acres and these are reported to have yielded two crops in the past nine years.

There follows a report by H. K. Dean of the Bureau of Plant Industry on the type of Agriculture suitable for this project.

Report on Crops - Baker Reclamation Project
H.K.Dean - Agronomist and Superintendent
Umatilla Experiment Farm.

The proposed Baker Reclamation Project, comprising about 40,000 acres of land, is from 2400 to 3000 feet above sea level; has soil varying from sandy loam to clay loam, rather rough topography with slopes from 5 to 20 per cent and an adequate water supply. These determining factors in the type of agriculture would indicate that it would be of general character with livestock, particularly dairy cattle and hogs as a basis. This is the type practiced on the river and creek bottoms now being farmed except that the crops are fed mostly to sheep and beef. The adjacent forest reserve is now fully stocked so extension along the latter line would not be possible. The distance from railroad is 12 to 20 miles which precludes the economic marketing of bulky crops under normal conditions.

Crops- Alfalfa is the principal forage crop of the district, which is fairly well adapted to its production. Two good crops and a short third are secured. The alfalfa weevil is now present in the vicinity of Baker but it is likely that control methods and substitute crops will at least partially control the pest. Table 1 is a summary of the yields of alfalfa on land now farmed within the project. These lands are along river and creek bottoms on generally slightly heavier soils than on the hills but it is believed that the yields on the hills would approximate those of the bottoms. Crop reports were secured on 1201 acres of alfalfa on 13 farms in the river valley proper. The yields showed a variation of from 1.7 to 5 tons per acre with the average 3.2 tons. Five creek valley farms reported an average yield of 2.38 tons from 113.5 acres.

Wheat and barley are the chief grain crops of the area. Table 2 gives the yields of wheat reported by 3 river valley and 6 tributary creek valley farmers. Twenty eight acres on the river bottom produced 790 bushels of wheat, an average of 28.2 bushels per acre. The yield in the creek bottoms from 197 acres was slightly higher, averaging 35 bushels per acre.

Corn would likely not produce enough grain to be as profitable as wheat or barley but the shorter-seasoned varieties could be used for silage. Under similar conditions in Eastern Oregon sunflowers have given higher silage yields than corn.

From the appearances of grasses growing throughout the region it is judged that mixed grass pastures would have good carrying capacity. Establishment of pastures on the sloping land would be difficult but that land could probably be best used for pastures on account of ease of pasture irrigation and of difficulty of harvesting other crops from steep land.

Taking the existing small orchards as an indication it is not believed that orchards would be profitable on account of the late spring frosts.

Crop Yields compared with existing Reclamation Projects:-

- The yields produced by some of the common crops on 7 Reclamation Service Projects in the northwest have been assembled in table 3. While these figures are for the year 1922 only, there is little variation in the yields from year to year and it is believed that they are quite closely comparable to those to be expected on the Baker Project. These projects in general have similar soil and climatic conditions to the Baker project but probably have a slightly lower average altitude than that project. The average yield of 140,000 acres of alfalfa on these projects was 3.6 tons per acre which is slightly higher than the figures for the Baker project. The average yield of wheat on 53,818 acres was 26 bushels as compared with 34.2 bushels average on both the river and creek bottom lands. The barley yield on the Baker Project would probably be about equal to that of the seven projects summarized while the corn fodder yield might be lower and the potatoes higher.

Table 1 - Average yield of alfalfa in tons per acre on river valley and creek valley lands already cropped on Baker Irrigation Project.*

Ranch number	Acres	Total Yield Tons	Average per acre tons.
	River Valley		
1	200	600	3.0
2	75	275	3.7
3	140	450	3.2
4	120	600	5.0
5	100	300	3.0
6	57	280	4.9
7	100	400	4.0
8	40	120	3.0
9	40	80	2.0
10	90	275	3.1
11	109	200	1.8
12	60	100	1.7
13	70	210	3.0
Sum and Average.:	1201	3890	3.2

Table 1 (Contd.)

Ranch number	Acres	Total Yield Tons	Average per acre tons.
	Creek Valleys		
14	15	23	1.5
15	15	45	3.0
16	60	100	1.7
17	8.5	40	4.7
18	15	62	4.1
Sum and Avg.	113.5	270	2.38

*These figures are from a farm management survey of the area made by R. P. Teele.
County assessor says the average is 3 tons.
One farmer says two crops will yield 3 tons. Sometimes get a third crop, making about 1/2 ton more.

Table 2 - Average yield of wheat in bushels per acre on river valley and creek valley lands already cropped on Baker Irrigation Project.*

Ranch number	Acres	Total Yield Bushels	Average per acre Bushels
	River Valley.		
1	2	40	20.0
2	16	500	31.3
3	10	250	25.0
Sum and Average:	28	790	28.2
	Creek Valleys.		
4	8	197	24.0
5	8	292	30.2
6	14	540	38.0
7	10	273	27.3
8	31	1100	35.5
9	126	4543	36.1
Sum and Average:	197	6895	35.0

*These figures are from a farm management survey of the area made by R. P. Teele.

Table 3 - Yields per acre of alfalfa, barley, wheat, corn grain, corn fodder and potatoes per acre on seven Northwest Reclamation Projects in 1922.

Project	Alfalfa	Barley	Wheat	Corn Grain	Corn Fodder	Potatoes
	Tons	Bu.	Bu.	Bu.	Tons	Bu.
Boise	4.6	28	32	51	11	290
King Hill	4.2	16	18.7	35	9.7	217
Minidoka pumping	2.6	21	28.6	25.6	9.9	236
Minidoka gravity	3.1	34	29	33	6.9	218
Yakima Sunnyside	4.0	26	35	44	6.0*	267
Yakima Tieton	3.0	20	23	41	12.8*	198
Umatilla	3.8	29	29	36	8.6	108
Average	3.6	25	26	38	9.2	219
Acreages on which averages are based	140,363	7067	53,818	13,443	1,292	39,588

*Designated as corn ensilage.

The above figures are taken from the project crop reports as published in the Reclamation Record.

In connection with this same question consultations were held with the Experiment Station workers of Oregon, Utah, and California. Prof. Paul V. Maris, Director of Extension of the Oregon Agricultural College has worked out and had published "An Agricultural Program for Oregon" which has been made use of in considering the type of agriculture for the Baker project.

Summarizing the information obtained together with personal observations, the following crops are considered adapted to the Lower Powder Valley:

Alfalfa hay, two good crops with a possible short third and very limited pasture or two good crops and good fall pasture.

Wheat, oats, and barley will mature.

Corn for ensilage only; root crops for stock feeding will yield well. Potatoes will not however prove profitable except to supply the local market as they will mature too late for early market.

Sugar beets and sugar beet seed will prove suitable. The growing of sugar beets will depend upon the building of a factory sufficiently near and on the willingness of settlers to grow beets. Mangels and other root crops for stock feeding will do well.

Clover and alfalfa seed can be grown successfully and in addition afford chaff as roughage for dry and young dairy stock as well as pigs and sheep. It is also possible to obtain a short first crop of alfalfa followed by a seed crop. In the present status of the alfalfa weevil, clover seed would be more profitable. Grasses of various kinds could be grown for pasturage.

Many of the hardier vegetables would do well and especially peas for canning. Due, however, to lack of transportation, such crops are for future consideration.

The type of farming that now promises best is dairying and stock raising. The dairy herd with pigs and chickens associated affords the basis of estimates of cash requirements and income discussed later in this report.

There is also opportunity for pure bred stock farming in sheep, cattle and swine. This industry would, however, come better at a later date.

PREPARING LAND FOR IRRIGATION AND IRRIGATION PRACTICE.

The lands of the project excepting those in the river bottom are elevated terraces with a smooth surface but broken topography. The lands as a whole are steep, having a general slope toward the river and more abrupt lateral slopes into the coulees or ravines.

A rather sparse and small growth of black sage now covers the area. Except in a few small areas in the river and coulee bottoms, the sage averages only 18 to 24 inches in height and not more than an inch or so in diameter. This sage can be readily grubbed out by hand or plowed out with the ordinary plow.

It would cost to grub the sage by hand, pile and burn from $4 to $5 per acre. A plowing following this would cost $2.50 to $3 per acre. To plow out the brush, and rake and burn it would cost $6 per acre.

Grubbing out by hand is preferable and is almost necessary when alfalfa or some other permanent crop is to be seeded the first year or when the lands are steep. If grain is to be grown the first year, plowing out the sage is permissible. The next succeeding plowing will, however, cost almost as much more as the additional cost of hand grubbing the sage.

The exterior fences should be four wire and posts every rod. Pasture fences and hog and chicken fences require stronger or different types of fences and would cost 20 per cent more than exterior fences. Good posts can be obtained locally at 15 cents to 20 cents each. The barbed wire and posts for a four wire fence with posts every rod would cost about $110 to $125 per mile depending upon local price of wire.

The land surface is smooth and would only in an occasional small area require more than a simple "Floating" to put it in good shape for irrigation. This "floating" would cost not to exceed 40¢ per acre.

Owing to the steepness of these lands there would be required rather more farm distributing ditches and waste ditches than upon the average irrigated farm. However, the type of agriculture is such as requires fewer ditches than an area permitting more intensive and diversified cropping.

Corrugation and flooding from contour ditches are the methods of irrigation best adapted to these lands. In the use of these methods the farm distributing ditches together with necessary controls would cost about $1.25 per acre.

If making the corrugations is included in this item there must be added 60 cents per acre. As all of the lands of each farm will not be corrugated, it is probably fair to assume an average cost of $1.50 to $1.70 per acre for farm distributing ditches and corrugations.

On steep lands or where "washing" is liable to occur, it is essential that small streams of water be used in irrigation and that no running together of these streams occur. For this purpose, the corrugation method of irrigation is well adapted provided sufficient care is taken in lying out and making the corrugations. The corrugations should run as nearly as practicable directly down the slopes. Because of the care necessary in lying out and making corrugations on steep lands, and average day's work for one man and four horses would be 10 acres or a cost of 60 cents per acre.

The irrigation practice suited to the Baker project as to the application of water is not different from that of other districts where steep lands are prevalent. The practice for the irrigation of alfalfa is one irrigation for each crop or three applications per season. For grain, two or three irrigations are given and other crops in proportion.

There is, however, a general sub-soil condition on this project that would make necessary in some instances a more frequent irrigation. The uplands, which includes that area above the river bottom and practically all lands of this project, are underlaid with a semi-impervious sub-soil. The practical effect of this is to prevent or check the deep penetration of irrigation water. The depth of soil wetted by an average irrigation would correspond to the depth of soil above the sub-soil. The depth of this sub-soil below the surface varies from a few inches to 36 inches, with an average of twenty to thirty inches. Near the top and edge of the benches, the depth to the sub-soil is seldom more than 18 inches. Water applied to these lands will tend to flow quite rapidly on top of the sub-soil into the ravines or coulees and thus be lost to the lands to which it was applied.

The following table gives the moisture equivalent, wilting percentage and field capacity for the soils of this area:

Field Capacity of Soils and Sub-Soils
Baker Project, Oregon.

Sample Number	Soil Type.	Depth of Samples Inches.	Moisture Equivalent: Per cent.	Wilting Percentage:	Available Storage Capacity. Per cent.	Available* Storage Capacity Acre Inches.
32	Silt Loam	0 - 18	36.0	19.57	16.43	2.37
33	" "	18 - 36	32.5	17.66	14.84	2.14
7	" "	0 - 7	27.4	14.89	12.51	1.80
8	Clay	7 - 15	27.4	14.89	12.51	1.80
9	"	15 - 22	29.9	16.25	13.65	1.97
44	Heavy Silt Loam	0 - 18	31.4	17.07	14.33	2.06
45	Clay Loam	18 - 30	36.8	20.00	16.80	2.25
20	Silt Loam	0 - 12	23.3	12.66	10.64	1.53
21	Silt Loam	12 - 22	24.7	13.42	11.28	1.62
22	" "	22 - 36	23.3	12.66	10.64	1.53
23	" "	0 - 12	26.1	14.18	11.92	1.72
24	" "	12 - 24	27.1	14.73	12.37	1.78
26	" "	0 - 12	30.4	16.52	15.88	2.29
27	" "	12 - 56	19.8	16.76	9.04	1.30
42	Coarse Loam	0 - 18	19.6	10.65	8.95	1.29
43	Heavy Clay Loam	10 - 18	22.4	12.17	10.23	1.47
Average of Surface Soils						1.87

*Storage capacity per foot in depth of soil.

The difference between the wilting percentages and the moisture equivalent percentages gives approximately the storage percentages for these soils. That is, this difference gives the maximum amount of water that will be held by these soils per foot in depth. In the last column is found this difference in percentage converted into acre-inches of water per foot of depth of soil.

The table shows that these soils hold only a moderate quantity of water and, being of the medium type, loose and rather open, will dry out quite rapidly. Where the depth to the sub-soil is less than

two feet, burning of crops will occur unless more frequent irrigation is practiced.

The irregularity in depth to sub-soil is prevalent all over the area and especially on the steeper slopes. This condition results in a farm unit that in most cases contains a number of variations in depth of surface soil and the different soil depths require different irrigation treatments to obtain the best results. The practical effect of this variation in this tract as well as in similar tracts is to have a very uneven crop and low yield. The field will show burned areas with no yields or small yields, thus cutting down the average yield. To irrigate sufficiently often to overcome this condition is expensive in time and water.

On steep slopes only very small heads of water can be used and these require constance attention if a good irrigation is obtained and washing prevented. An inexperienced irrigator will soon be in difficulty, resulting in a low yield and gullied fields.

The steep lands require from 25 per cent to 50 per cent more time to irrigate than flatter lands and yields average 10 per cent to 20 per cent less on the steep lands.

There are in this area now two or more alfalfa fields on land averaging in slope from 10 to 16 degrees and these show the effects of washing and burning.

There is prevalent in the soils of the benches only a small amount of alkali. More alkali occurs near the river bottom. In many areas along the river bottom, alkali has accumulated in injurious quantities. Water logging has occurred also in the river bottom and on some of the

lower slopes. Sub-soil conditions on the bench lands are such that excess irrigation water and seepage from the canals and ditches will drain rapidly into the coulees and finally onto the lower benches and into the river bottom. The experience of other districts justifies the prediction of at least a partial waterlogging of the coulee bottoms and lower benches unless unusual care is exercised in irrigation together with some preventative drainage. The steep side slopes and coulee bottoms are not, except in a very few instances, to be considered equal to the good lands and may not be classed higher than poor hay and pasture lands.

The effect of excessive slopes in an irrigation project are for the most part detrimental. Every farm operation from clearing to harvesting is more expensive and time consuming, the steeper the slope. Upon slopes of more than 10 per cent the practical difficulties of irrigation in diversified farming are of consequence. It is difficult to obtain a satisfactory distribution of water and thus prevent burning of the crop. It is difficult to prevent "washing"; ditches and corrugations require more frequent cleaning or building; and as the slope is greater it becomes impracticable ot handle the water economically. The soil of the Baker project is not what is termed "bad to wash" but where plowed will wash readily at slopes of 8 to 10 per cent.

On slopes of 8 or 10 per cent and greater it will be necessary to give to the application of water to the land constant attention. On flatter slopes, the water may be "set" at dark and allowed to run all night without attention. This would be a dangerous and probably ruinous practice on the Baker project.

Plowing is more time consuming and difficult on steep lands and so also are the seeding and other tillage operations.

Haying is more difficult the steeper the slopes and it may be possible to load from one side only.

The effect of slope is then to slow up and make more expensive all farm operations and tend to lower yields.

DOMESTIC WATER SUPPLY.

A pure water supply for house use is one of the first consideration in home building. It is also essential for dairy cattle to have pure water. During the low-flow period of Powder River in the summer and fall, the water may or may not be suitable for culinary use. Assuming, however, that it is of suitable quality it is not feasible to keep water in the ditches during the non-irrigation period. Such a course is wasteful of water where storage is practiced as in the Baker Project and has the additional disadvantage of the liability of alkali accumulation and water-logging of the lower lands through seepage from the ditches. If the river is to be the only source of domestic water other than snow then a system of farm reservoirs or cisterns or both must be adopted. The geology of the valley is favorable to a general underground water supply over most of the area that would yield a suitable domestic supply. There are now within the area several wells with the water from 10 to 75 feet below the surface. Provision should be made at each farm unit for a well properly equipped to furnish the domestic water and canal water used only incidentally for stock water during the irrigation season and not at all at other seasons of the year. It is reasonably certain that such wells could be secured in most of, if not all, the coulees. A well equipped to furnish the necessary domestic water would cost about $150 on the average.

SIZE OF FARM UNITS.

The size of the farm unit should be such as will afford a living for the family, provide sufficient additional income that by proper management will pay for the farm in a reasonable time and afford a reasonable income on the investment.

The individual, available capital, productivity of the soil, locality, and various other factors are important in determining the size of unit. The experience of the farmer is one of the most potent factors and the more limited the experience the smaller should be the farm unit.

If the Baker project were divided into farm units of equal size hardly any two would have the same productive power. The land classification shows several classes and each class has a different practical productive power or a different cost of production. In other words, the different classes of land represent differences in net agricultural return. The land classification map shows the irregular distribution of these classes. It naturally follows that if the whole area is divided into farm units of equal area, the net return possible from these units will differ, hence, the amount that can be paid per farm unit will vary. Again a farm unit should be designed not fundamentally upon east, west, north and south lines but upon a basis affording the best and most economic utilization of those lands. The farm unit should be laid out to best fit the irrigation layout, to afford natural drainage, and, if necessary, permit at least cost, artificial drainage, to afford easy grades for roads and to facilitate farm operations. For instance in the Baker project, if roads were due east and west or due north and south impossible grades would be encountered on most if not all of them.

All lands within the exterior limits of the project should be included in the layout. A farm unit might include an area of high or rough land not irrigable and therefore receiving little benefit from irrigation, in which case no construction, operation, or other project charge can be made but the land would still be of some value to the farmer. On the other hand, there may be included within a farm allotment an area susceptible of irrigation for a limited time and afterwards receiving indirect benefit with little or no direct application of water, in which case there should be an equitable project charge.

If the size of the farm unit in the Baker project be fixed on a basis of the productivity of the soil within that unit and laid out on topographic lines, the farm units will be equitable and economic. Such a layout is indicated in Fig. 1. The layout indicated, for lack of sufficient detail, is not precise, but is merely to picture such a layout as is suggested.

CAPITAL REQUIREMENTS

The following estimate of the capital required by an average settler on such a project as that proposed at Baker, Ore., is based upon an area of 80 acres of first class irrigable land or its equivalent. The type of agriculture is dairying and the raising of swine, chickens, and clover or alfalfa seed.

It is recognized that probably no two farms will have exactly the same number of the various kinds of animals but the final analysis of cost and returns will not differ materially.

It is based further upon the present plan of payment of construction cost under the Reclamation Act. Section 1 of the act of August 13, 1914, known as the Extension Act, provides that a person making application for a water right shall "pay into the reclamation fund 5 per centum of the construction charge fixed for his land as an initial installment, and shall pay the balance of said charge in fifteen annual installments, the first five of which shall each be 5 per centum of the construction charge and the remainder shall each be 7 per centum until the whole amount shall have been paid. The first of the annual installments shall become due and payable on December 1 of the fifth calendar year after the initial installment."

The construction cost is estimated at an average of $200 per acre (very little difference would result the first six years if the cost were taken at $160 per acre) and land at the present prevailing price for privately owned dry land of $5 per acre payable in five equal installments of $1 each and 6 per cent interest on deferred payments. In the case of public land a settler may acquire an 80 acre tract for the usual Land Office fees. Annual assessments for operation and maintenance are assumed to equal the average for existing Government projects - $2.20 per acre - as shown by the Census of 1920.

The estimate of capital requirements together with estimated income is shown in table form for each of the first six years.

In considering the table it must be kept in mind that a farmer to succeed must have his farm fully planted, stocked and equipped at the end of the fifth year as in the sixth year payments commerce on the construction cost.

In order to accomplish this with the least total capital requirement, it is necessary to have all the land producing the third year.

It is recognized that some settlers can get through with less capital and others will probably require more than that given in the table.

The size of the family is also an important element when considering the labor cost. In the present analysis is considered a family with no children to assist with the farm work. If there is child help there might be a small reduction in cash required for labor but most of such labor is offset by additional living costs, school expenses, etc.

Capital Requirements

Investment

Item	Year 1	2	3	4	5	6
Water Charges	(1)$800	$ ---	$ ---	$ ---	$ ---	(1)$800
Land	80	99	94	90	85	---
House, Building, etc. (Material only)	500	---	200	---	100	---
Barns	300	150	150	---	---	---
Chicken House	50	25	---	---	---	---
Pig Pens	40	40	40	---	---	---
Well	150	---	---	---	---	---
Fence	300	120	50	---	---	---
Silo & Equipment	---	---	---	400	---	---
Auto	250	---	---	---	300	---
Team	200	---	---	---	---	---
Harness	65	---	---	---	---	---
Cows	500	500	500	---	---	---
Bull	---	100	50	---	---	---
Pigs	70	70	150	---	---	---
Chickens	50	---	---	---	---	---
Sub-total	3355	1104	1234	490	485	800

(1) Five per cent of a charge of $200 per acre, for 80 acres.

Investment (Cont'd.)

Equipment.

Item	Year 1	2	3	4	5	6
Plows	$75	$25	$---	$---	$---	$---
Harrow	40	---	---	---	---	---
Mower	90	---	---	---	---	---
Rake	50	---	---	---	---	---
Wagon	175	---	---	---	---	---
Hay rack	15	---	---	---	---	---
Hay Stacker	100	---	---	---	---	---
Dairy Implements	120	---	25	---	---	---
Corrugator	15	---	---	---	---	---
Small tools	40	15	---	---	---	---
Sub total	720	40	25			

Operation.

Items	Year 1	2	3	4	5	6
Seed	$45	$200	$20	$25	$25	$25
Harvesting	20	16	16	16	16	16
Threshing	30	50	75	75	75	75
Labor	350	150	250	300	300	300
Feed	450	100	250	250	250	250
Taxes	120	125	135	150	150	150
Insurance	25	---	---	40	---	---
Water, O. & M.	120	176	176	176	176	176
Repairs	25	75	100	100	100	100
Veterinary	25	50	75	75	75	75
Incidentals	20	25	30	40	40	40
Auto	150	150	150	150	150	150
Sub total	1380	1117	1277	1397	1357	1357

Personal

Furniture	$400	$---	$100	$---	$ 50	$---
Living	600	600	600	600	600	600
Amusement	50	50	50	50	50	50
Sub total	1050	650	750	650	700	650

Summary

Items	Year 1	2	3	4	5	6
Investment	$3355	$1104	$1234	$490	$485	$800
Equipment	720	40	25	---	---	----
Operation	1380	1117	1277	1397	1357	1357
Personal	1050	650	750	650	700	650
TOTAL	6505	2911	3286	2537	2542	2807
INCOME	575	1950	3090	3340	3340	3340
DEFICIT	5930	961	196	---	---	---
SURPLUS	---	---	---	803	798	533

The capital required the first three years in excess of income is $7087.

It is assumed the entire 80 acres is to be in crop or pasture by the second year and in full bearing the third. It is also assumed there will be in crop the first year 10 acres of alfalfa planted with a nurse crop of oats and cut for hay; 10 acres of grain, and a family garden. The planting for the third year is 30 acres of alfalfa, 15 acres of clover for seed, 20 acres of pasture, 10 acres of grain and 5 acres in garden, yards, etc.

For the fourth and following years there will be introduced 5 acres of ensilage in place of some alfalfa and some grain. It is assumed there will be purchased 2 horses immediately, 5 grade dairy cows will be purchased at the end of three months as also fifty chickens. Two brood sows will be purchased at the end of 5 months. At the beginning of the second yard 5 more grade dairy cows and 2 sows; at the beginning of the third year, 5 more cows and 3 more sows will be purchased. The final

live stock consists of 2 horses, 15 grade dairy cows, an interest in a bull, and 7 sows and one boar. Additional labor will be required each year, the first year to assist with building, primarily, and later with general farm work.

The following table gives an estimate of the income over a period of six years. In the sixth year payments on construction charges will begin.

Estimate of Income

Source	Year 1	2	3	4	5	6
Dairy	$375	$1000	$1500	$1500	$1500	$1500
Pigs	150	600	840	840	840	840
Chickens	50	100	150	150	150	150
Clover seed	---	---	500	750	750	750
Other sources	---	250	100	100	100	100
Total	575	1950	3090	3340	3340	3340

The above incomes are based on the assumption that approximately the present prices will prevail and that ready markets will be at hand.

If the income for each year be subtracted from the capital required each year there will be shown the net capital requirement and the annual deficit or gain.

Capital Requirements Year by Year.

	Year 1	2	3	4	5	6
Capital	$6505	$2911	$3286	$2537	$2542	$2807
Income	575	1950	3090	3340	3340	3340
Deficit	5930	961	196	---	---	---
Gain	---	---	---	803	798	533

The capital required the first year in excess of the income is $5930, the second year $961 and the third year $196, or a total capital at the end of the third year of $7087. From the fourth year or after the farm is fully stocked and each acre producing there is an excess of income over cash outlay. In these calculations no allowance has been made for the labor of the farmer.

It would seem from the above analysis that if the settler came there with in round numbers, $7100 in cash or its equivalent, he could meet the payments for the construction cost and ultimately pay for the water and equipped farm.

It is, however, very rarely that a prospective settler could be found with $7100 capital that would be willing to settle on the raw land of a new irrigation project. The usual settler has not to exceed $1500 and with this capital he could not survive the first year without large financial assistance. The settler has no assets upon which to borrow, but presuming he is financed with additional capital he would have to pay at least 8 per cent interest.

Instead of $7100 capital required by a settler having that amount of cash, the settler having only $1500 would have to borrow $6401 or a total capital requirement of $7901. Of this amount he would require $4430 the first year, $1315 the second year and $656 the third year as may be seen by the following analysis.

Capital requirements for the settler having only $1500.

First year:

Estimated required capital	$6506
Cash on hand.....	$1500
Estimated income.....	575
Total cash.....	$2075
Necessary to borrow.....	$4430

Second year:

Estimated capital required	$2911
Interest	354
	$3265
Estimated income	$1950
Necessary to borrow	$1315

Third year:

Estimated capital required	$3286
Interest	460
	$3746
Estimated income	$3090
Necessary to borrow	$ 656
	$6401

Fourth year:

Estimated capital required	$2537
Interest	512
	$3049
Income	$3340
Cash Balance	$ 291

Fifth year:

Estimated capital required	$2542
Interest	512
	$3054
Income	$3340
Cash Balance	$ 286
Total gain	$ 577

At the beginning of the sixth year the settler could have no more than $529.

Sixth year:

Estimated capital required	$2807
Interest	512
	$3319

Income	$3340
Cash Balance	$ 21

Assuming that the expenses and the income were the same for the following four years as for the sixth year then the settler could break even for these four years. The eleventh year there is an additional 2 per cent to pay on the construction cost which would increase the capital requirements $320 per year for the next ten years.

Eleventh year:

Estimated capital required	$3127
Interest	512
	$3639
Income	$3340
Deficit	$ 299

Unless the settler could increase his income by $299 per year or decrease his expenditures by this amount, he could not meet his payments. Assuming that the settler did follow such a reduced program and make all payments as outlined, he would still have received no interest on the investment and practically no labor income other than a meagre living. His assets would be about as follows:

80 acres land and water at $212.50	(1) $17,000
15 head cows	1,500
Interest in bull	150
Pigs	300
Horses	200
House and barns	1500
Implements and tools	500
Well	150
Silo	250

Brought forward		$21,550
Auto		200
Furniture		250
	Total	$22,000

(1) In the table it is assumed the land and water are worth the same as the original cost of $200 per acre for water, $5 per acre for land and $7.50 an acre for improvements in the way of clearing and fencing but without crops. It is impossible to predict the value of lands 20 years hence. If they were measured by the present values or those of 1914, the above inventory would probably bring $5000 to $6000 less than the inventory.

The settler would owe upon this $6400 or the original borrowed capital.

It would take the settler about 7 years additional to pay off the $6400 borrowed capital, so it can be predicted that the settler who arrived on this project with a capital of $1500 would have at the end of twenty-seven years of the most careful management assets of from $15,000 to $22,000.

In the above calculations no provision has been made for contingencies such as a partial crop failure, ravages of disease among the live stock, serious illness of the settler, and the like. There has been made no provision after the fifth year for improvements or general replacements on the farm. No allowance has been made for interest on the investment.

The exceptional settler might follow such a program but the majority would fail and each failure may mean an added burden to those remaining.

It is possible to make some cuts in the above estimate of ex-

pense if the family is willing to go through the larger part of the twenty years with no comforts or pleasure.

It would be possible, for instance, to get along with a house costing two-thirds of the above allotment. The same is true of barns but the income would also be decreased. The auto could be left out but in its place must be a light conveyance and light harness. Second hand machinery could be used and the living expense could be cut to $500 a year and so on down the list. However, the families that could be induced to settle the project under these conditions would be few and many of them undesirable.

In making an estimate of expense it must be sufficiently liberal to attract and satisfy the average family so there will be the least number of removals from the project. Each failure means an additional burden to some one. Lapsed payments must be made up and in case of farm allotments remaining unoccupied, the operation and maintenance charges must be paid in full by the district.

In the above estimate of costs, it is assumed no delinquent payments have accured to the land. Each year of delinquency of operation and maintenance charges means for the next year an additional $2.20 per acre plus the penalty of 1 per cent per month.

With the estimated high construction cost it is imperative that all farm allotments be quickly settled. The rapid settlement or irrigation projects of the West is not the rule.

It is contended locally that these lands could be settled quickly very largely by local people. This, however, is very questionable, and,

besides, the majority of the local people are not familiar with the type of farming outlined.

In the above analysis of costs the construction charge for water has been taken as $200 per acre. If we assume a cost of $160 as approximately the estimate given in the Reclamation Service Report of January 1923, the following analysis would result for the settler having only $1500 in capital.

During the first five years the only difference would be that the settler would save $160 in the payment the first year on the construction cost and the interest at 8 per cent on this $160 for five years or a total of $224.

Sixth year:

Estimated capital required	$2647
Interest	494
	$3141
Income	$3340
Gain	$ 199

The expense and income would be the same for the seventh, eighth, ninth and tenth years. Beginning with the eleventh and nine following years thereis the 2 per cent additional to pay.

Eleventh year:

Estimated capital required	$2743
Interest	494
	$3237
Income	$3340
Gain	$ 103

These figures show a gain of income for the eleventh year of $402 over that shown by the first analysis where the construction cost

for water was higher.

Taking either estimate the outlook is not enticing to a prospective settler as there is practically no margin of safety. The question of financing a settler with only $1500 capital is one for some agency such as the State or Federal Government as no private agency would assume the risk. Many private banks will finance a farmer for dairy cattle provided one-half the monthly milk check be applied on the debt. Such a procedure would not help this settler.

The settler with $7200 to invest can meet his payments but can not in addition make a reasonable interest on his total investment in addition to a reasonable labor income.

Capital Requirements of Land having Partial Water Right.

According to the Reclamation Service Report of January 1923, there are more than 3000 acres in the proposed project having a partial water supply. The report apportions their share of construction cost at approximately $49 per acre. According to the Bureau of Soils survey the apportionment of construction cost to these lands is $60 per acre. This means to these old lands that each acre so classified would have to pay, the first year the water was ready for use, a construction charge of $3 per acre and an operation and maintenance charge of $2.20 per acre. The second to fifth years inclusive would be the operation and maintenance charge of $2.20 per acre and no construction charge. The sixth to tenth years inclusive, these lands would have the same to pay as for the first year, or $5.20 per acre. The eleventh to twentieth years there is an additional construction charge of 2 per cent making a total of $6.40 per acre.

In addition to the above charges there is at present an average mortgage debt of $58 per acre on these lands at interest rates varying from 5-1/2 per cent to 8 per cent. If an interest rate of 6 per cent be assumed it means an additional $3.48 per acre per year. Assuming there is no part of the mortgage paid until after the twentieth year, the settlers on these lands having a partial water supply would have to pay in addition to an increased property valuation tax the following:

First year	$8.68 per acre.
Second to fifth (inc)	5.68 per acre.
Sixth to tenth (inc)	8.68 per acre.
Eleventh to twentieth (inc)	9.88 per acre.

To meet these payments he would have to bring each acre into a state of production. He might and in many cases would have to change his type of farming. This last would necessitate some such an outlay for animals, etc. as on the new lands. The settler on the old lands would of course have some crops already in; some fencing, buildings, farm machinery, horses, and the like. Each farmer would, therefore, have a different capital requirement as the areas of these old farms are different and they are differently equipped. Their payments for water will be at least from $8 to $10 per acre per year, except for the second, third, fourth, and fifth years.